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Users Manual**

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Division

INCC Software Users Manual

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Introduction

Overview

INCC is a general purpose neutron coincidence counting program that runs on IBM personal computers running Microsoft Windows 95, Windows 98 or Windows NT. It is intended for nondestructive passive and active neutron verification applications. Passive neutron verification techniques include calibration curve, known alpha, known multiplication, add-a-source, multiplicity, curium ratio and truncated multiplicity. Active techniques include calibration curve, multiplicity, collar and active/passive. You can use all of these techniques with INCC. Active multiplicity presently determines the neutron multiplication of a uranium item, but does not determine the uranium mass.

You can verify items using multiple verification techniques at the same time by selecting multiple analysis methods. For example, you might verify plutonium items using the passive calibration curve and the known alpha techniques simultaneously. Collar verifications cannot be combined with other verification techniques. You can group verification measurements by inspection number.

You can use any of the common coincidence electronics packages: the Canberra JSR-11 and JSR-12, the Canberra JSR-14 in either PSR or JSR-12 mode, the Los Alamos MSR4 multiplicity module, the Canberra 2150 multiplicity module (a commercial version of the MSR4), the Los Alamos and Aquila portable shift register (PSR), the Los Alamos intelligent shift register (ISR) and the Los Alamos dual gated shift register (DGSR). To use the Canberra JSR-14, you must use the Canberra program to set the high voltage mode to “portable”.

All measurement results are stored in both database and text files. You can save and restore the entire database or measurement data, measurement (detector) parameters and calibration parameters for transfer between computers. You can import Stratum Authority and Item Relevant Data files from IFSS, SPAN and NMAX. You can export files for the Operator-Inspector Measurement Database and Logsheet and you can export Performance Monitoring files. You can review, create reports and print any measurement data and results at any time. When the program is started you will be warned if the hard disk is more than 90 percent full. If you see this warning you need to free

up some disk space. If the hard disk becomes 95 percent full, measurement data acquisition will be disabled in order to protect the database from becoming corrupted when the hard disk is completely full.

You can develop calibration curves with the INCC program. To do this, collect data from calibration standards and fit the data with the Deming least squares fitting program which can be called by the INCC program. The resulting calibration coefficients are automatically transferred to calibration files and you are ready for verification measurements. You can only use Deming for the passive and active calibration curve, known alpha, and add-a-source analysis methods.

You can plot calibration curves with the calibration and verification measurement data to produce graphical summaries of calibration and verification results.

You can write a summary of verification results, one measurement per line, in comma separated variable format for input to a spreadsheet program such as EXCEL.

Measurement control options are included for quality control tests. They include normalization and precision tests to check the detector efficiency and stability, and raw data tests and outlier tests to check for data consistency.

You can calculate the mass and display results for verification measurement data files imported from Radiation Review. You can also process and display results for background and normalization measurement data files imported from Radiation Review. These files are created from measurements made by Shift Register Collect or Multi-Instrument Collect running in unattended mode. The results will remain in the database, and can be reviewed or reanalyzed at any time.

If the mass has previously been calculated using the import function, you can display the results for the verification or normalization measurement corresponding to a peak on a graph in Radiation Review by simply clicking on or near the peak and requesting INCC data display.

Clicking on *Tools / Select Another Review Tool* will provide the user with the ability to have Radiation Review display the peak corresponding to the most recently displayed INCC verification measurement.

This Document's Conventions

1. Italics are used to denote menu selections to be made by the user, for example, select *Measurement Parameters*.
2. A sequence of operations is indicated by using a vertical bar to separate the individual operations, for example, select *File | Exit INCC* means select the File menu and then the Exit option from that menu.

3. File names and file path names are specified with the Courier New font, for example, `c:\incc_310\data`.
4. Character strings displayed on the screen are surrounded by double quotes, for example, you would see the message “System Error Cannot read from drive A.” if you attempted to do a save without a disk in drive A.
5. Square brackets are used to denote single keystrokes that cannot be represented by a single character, for example, [Enter].
6. Character strings that are to be typed in by the user are in boldface type, for example, **a:install[Enter]**.
7. Warnings for functions that may inadvertently cause a loss of data or parameters are in boldface type.

Windows Conventions

1. The underlined character in a menu item is called a hot key. Selection of a menu item or button can be accomplished by using the mouse to click where desired or by typing [Alt] [hot key] for main menu and button selections, and simply typing the [hot key] for all other menu selections.
2. Typing [Enter] from within a dialog box usually has the same effect as selecting the “OK” button, and will result in exiting the dialog box. Use [Tab] and [Shift][Tab] to move down and up respectively between dialog box fields. The mouse can be used to move to a non-contiguous field.
3. Selection of multiple lines, for example when selecting measurements to delete, follows the windows standard.

Using the mouse:

- a. Click on the first line you want to select.
- b. Press and hold down the [Shift] key while you click on the last line you want to select.
- c. To select lines out of sequence, press and hold down the [Ctrl] key while you click on each line you want to select.

Using the keyboard:

- a. Use the arrow keys to move to the first line you want to select.
- b. Press and hold down the [Shift] key while you select the remaining lines you want.

Units

Unless otherwise stated, time is in seconds, mass is in grams, rates are in counts per second, lengths are in centimeters and isotopic composition is in weight percent. To convert from parts per million (ppm) to weight percent, divide by 10,000.

Date format

The format in a date edit field will always be whatever you have chosen for your computer. You will get an error message that tells you the correct format if you try to enter an invalid date. You may use “Regional Settings” in the “Control Panel” group to change the date format. The date format for results will always be YY.MM.DD, regardless of what format you have chosen for your computer. The years 52 through 99 represent 1952 through 1999. The years 00 through 51 represent 2000 through 2051. All arithmetic involving years, such as the decay correction of isotopics, is done in Julian time so that the two digit year is not a problem.

Getting started

System Requirements

The software requires:

- 33 MHz 486 or better CPU
- 16 MB RAM minimum
- 200 MB available space on the fixed disk
- 1.44 MB floppy disk
- One serial port unless using add-a-source, then two serial ports
- Mouse or other pointing device
- VGA color monitor or better
- Microsoft Windows 95, Windows 98 or Windows NT

Installation Procedure

This installation procedure will overwrite your existing version of INCC and its database. Be sure to make a backup of your current version and all the subdirectories before you proceed. All data in your current database will be overwritten.

One way to create a backup (in the new subdirectory `incc_bac`) is to type `xcopy c:\incc_310*. * c:\incc_bac /s /e` from a DOS prompt.

To perform the installation using a Windows 95 style user interface:

1. Insert the INCC 3.20 install disk #1 in drive A.
2. Click on Start.
3. Click on Run.

4. Type **a:install[Enter]** in the Run dialog box.
5. Click on Start, then click on Programs, then click on the INCC 3.20 file folder and then click on the INCC 3.20 icon. The program should start up, and display the main menu in Inspection mode.

Procedures

System Setup

1. Start the INCC program, select *View* and click on *Maintain* to get into the Maintenance Menu.
2. Select *Maintain / Material Type Add/Delete*, and prepare a list of material types to match your items. You can change this list at any time.
3. Select *Maintain / Calibration / Analysis Methods*, and check the analysis methods you want to use for each material type. You can change the selections later at any time.
4. Select *Maintain / Background Setup*, and set all background rates to zero.
5. Select *Maintain / Normalization Setup*, select the type of normalization and set the normalization constant and error to one. Enter the reference ^{252}Cf doubles rate or the reference AmLi singles rate and its measurement date. Check the box if you are using an add-a-source ^{252}Cf source as the reference source, and enter the measurement position. If you do not know these values yet, enter arbitrary values temporarily. You cannot do a normalization test until these values are known and entered here.
6. Select *Setup / Measurement Parameters*.
 - a. Select the type of shift register electronics used by your system and the serial port to which the shift register is connected.
 - b. Enter the predelay, gate length, and high voltage. Some of these may be manual settings (outside the program), depending on the type of shift register electronics used.
 - c. Enter the detector die-away time and the deadtime coefficients A and B.
 - d. If any of your planned measurements involve multiplicity analysis, enter the efficiency, multiplicity deadtime, and the doubles and triples gate fractions.
7. Select *Maintain / QC and Test Parameters*. Set the entries to their default values: (from top to bottom) 1000, 0.1, 4, 3, 100, box checked, 3, 1, 1, 99, 10, and 1.

8. Select *Maintain / Archive*, and make sure that your data sets will be saved as long as you need them.
9. If you are using an add-a-source system, select *Maintain / Add-a-source Setup*, and enter the add-a-source parameters for either the CompuMotor or PLC.
10. You will need a set of calibration parameters for each analysis method for each material type that you will verify. If you already have these values, select *Maintain / Calibration* and select an analysis method and enter your parameters for each material type. Repeat for all other analysis methods you will use. If you do not have these values yet, you can not verify until you get the calibration parameters.

Inspector Verification Measurement Procedure

1. Turn on the computer and select *View / Maintain* to get into maintenance mode.
2. Go to *Setup / Facility Inspection* and enter information as appropriate.
3. Go to *Setup / Isotopics* and enter all the isotopics you will need.
4. Go to *Setup / Item Data Entry* and enter the information for all the items you will measure.
5. Go to *Acquire / Background* and enter information as required and do the background measurement. Print a background report.
6. Go to *Acquire / Normalization* and enter information as required and do the normalization measurement. Print a normalization report.
7. Go to *Acquire / Verification* and follow the Online Help under Procedures - Verification measurements.
8. After each measurement, print a measurement report for that measurement.
9. When all measurements are finished go to *Report / Verification Summary* and print a summary report by instrument and by stratum. You can also back up the summary data at the same time.
10. Go to *File / Backup All Data* and backup all data (the entire database) to a floppy disk.

Background Measurements

1. Select *Acquire / Background*.
2. Enter any comment you want to make.
3. Enter the count time per cycle in seconds and the number of cycles, or using measurement precision, enter the percent precision and the lower and upper limits on the number of cycles.
4. Select "Shift register" as the data source.

5. Select quality control (QC) tests on, that is, check the box.
6. Check the print box if you want printed results at the end of the measurement. You can always print results later under *Report / Background* if you do not want to print now. Check the ending comment box if you want to be able to add a description of the measurement when it has completed.
7. Select the "OK" button and you will get a choice of passive or active well configurations. Select passive for normal room background measurements and active for background measurements in active systems when the AmLi sources are in the detector.
8. Select the "OK" button and the background measurement will start.
9. You can end the measurement early, if desired, by selecting "Quit measurement with results" or "Abort measurement" button. If you choose the quit option, the results will be calculated with the data from the cycles completed so far. If you choose the abort option all the data from the current measurement will be destroyed.
10. When the measurement is finished, you will get two results windows, one for the cycle data and one for the final results. The last ten results windows will stay on the screen unless you close them manually.

Initial Source Measurements

1. Select *Acquire / Initial Source*. You must be in Maintenance mode.
Note: Initial source measurements are not made for UNCL detectors because they have been precalibrated and cross-referenced.
2. Select Cf252 or AmLi as the source type.
Note: If you have an add-a-source system and want to use the add-a-source as the normalization source, click on the box "Use add-a-source Cf252 source for normalization test measurements" and enter the desired source position.
3. Enter the source id and a comment if desired.
4. Select "Shift register" as the data source.
5. Select "Use number of cycles" or "Use measurement precision" to determine the measurement time. If you select the number of cycles, enter the count time per cycle; if you select precision, enter the measurement precision and the minimum and maximum number of runs.
6. Check the "QC tests" box.
7. Check the "Print results" box if you want the results printed automatically at the end of the measurement. You can always print the results manually at the end of the measurement and you can always recall the results under *Report / Initial Source* if you want to print the results later.

8. Check "Comment at end of measurement" if you want to enter a comment after the measurement is completed.
9. Click OK to start the measurement.
10. You can end the measurement early, if desired, by selecting "Quit measurement with results" or "Abort measurement" button. If you choose the quit option, the results will be calculated with the data from the cycles completed so far. If you choose the abort option, all the data from the current measurement will be destroyed.
11. When the measurement is finished, you will get two results windows -- one for the cycle data and one for the final results. The last ten results windows will stay on the screen unless you close them manually. The reference rate and date are transferred to the database. You can check this by looking at the rate and date under Maintain | Normalization setup.

Normalization Measurements

1. Select *Acquire / Normalization*.
2. Enter any comment you want to make.
3. Enter the count time per cycle in seconds and the number of cycles, or using measurement precision, enter the percent precision and the lower and upper limits on the number of cycles. If you are using the sample standard deviation error calculation method, the number of cycles should be at least ten.
4. Select "Shift register" as the data source.
5. Select quality control (QC) tests on, that is, check the box.
6. Check the print box if you want printed results at the end of the measurement. You can always print results later under *Report / Normalization* if you do not want to print now. Check the ending comment box if you want to be able to add a description of the measurement when it has completed.
7. Select the "OK" button and the normalization measurement will start.
8. You can end the measurement early, if desired, by selecting "Quit measurement with results" or "Abort measurement" button. If you choose the quit option, the results will be calculated with the data from the cycles completed so far. If you choose the abort option all the data from the current measurement will be destroyed.
9. When the measurement is finished, you will get two results windows, one for the cycle data and one for the final results. The last ten results windows will stay on the screen unless you close them manually. The results for the normalization measurement are the ratio of expected to measured doubles rates for the reference ^{252}Cf source and the standard deviation of the ratio. If the ratio is more than three standard deviations from unity, you will get a "Fail" message.

Precision Measurements

1. Select *Acquire / Precision*. You must be in Maintenance mode.
2. Enter any comment you want to make.
3. Enter the count time per cycle in seconds and the number of cycles, or using measurement precision, enter the percent precision and the lower and upper limits on the number of cycles.
4. Select "Shift register" as the data source.
5. Select quality control (QC) tests on, that is, check the box.
6. Check the print box if you want printed results at the end of the measurement. You can always print results later under *Report / Precision* if you do not want to print now. Check the ending comment box if you want to be able to add a description of the measurement when it has completed.
7. Select the "OK" button and the precision measurement will start.
8. You can end the measurement early, if desired, by selecting "Quit measurement with results" or "Abort measurement" button. If you choose the quit option, the results will be calculated with the data from the cycles completed so far. If you choose the abort option all the data from the current measurement will be destroyed.
9. When the measurement is finished, you will get two results windows, one for the cycle data and one for the final result. The last ten results windows will stay on the screen unless you close them manually. The results for the precision test are the number of cycles, the chi-square lower and upper limits, the sample and theoretical variance and the chi-square value. If this value falls outside the lower or upper limits, you will get a "Fail" message.

Verification Measurements

1. Select *Acquire / Verification*.
2. Select an item id from the drop down list or type in a new item id and any comment you want to make.
3. Enter the count time per cycle in seconds and the number of cycles, or using measurement precision, enter the percent precision and the lower and upper limits on the number of cycles.
4. Select "Shift register" as the data source.
5. Select quality control (QC) tests on, that is, check the box.
6. Check the print box if you want printed results at the end of the measurement. You can always print results later under *Report / Verification* if you do not want to print now.

Check the ending comment box if you want to be able to add a description of the measurement when it has completed.

7. Select the material type, material balance area, stratum id, inventory change code and I/O code for your verification item.
8. If you want to do a verification measurement, that is, if you want to compare the assay mass with a declared mass, enter the declared mass. Otherwise, enter zero for the declared mass.
9. Select the "Isotopics" button and enter the isotopic composition for Pu items. For uranium items, select "Default" for the isotopic composition.
10. Select the "OK" button and the verification measurement will start.
11. You can end the measurement early, if desired, by selecting "Quit measurement with results" or "Abort measurement" button. If you choose the quit option, the results will be calculated with the data from the cycles completed so far. If you choose the abort option all the data from the current measurement will be destroyed.
12. When the measurement is finished, you will get two results windows, one for the cycle data and one for the final results. The last ten results windows will stay on the screen unless you close them manually. The final results for an verification measurement are the assay mass and standard deviation for each analysis method that you selected. The results from the "normal" (primary) analysis method will be highlighted. In addition, if you entered a declared mass, you will get a comparison between the assay and declared mass for each analysis method that you selected.

Calibration Measurements

1. Select *Acquire / Calibration*. You must be in Maintenance mode.
2. Select the material type for your calibration standard.
3. Select an item id from the drop down list or type in a new item id, type in the known mass of your standard.
4. Enter any comment you want to make.
5. Enter the count time per cycle in seconds and the number of cycles, or using measurement precision, enter the percent precision and the lower and upper limits on the number of cycles.
6. Select "Shift register" as the data source.
7. Select quality control (QC) tests on, that is, check the box.
8. Check the print box if you want printed results at the end of the measurement. You can always print results later under *Report / Calibration* if you do not want to print now.

Check the ending comment box if you want to be able to add a description of the measurement when it has completed.

9. Select the "Isotopics" button and enter the isotopic composition for your calibration standard.
10. Analysis methods for which you want to calibrate must have already been selected from *Maintain / Calibration / Analysis Methods*. There are four analysis methods that you can use for calibration in this program: passive calibration curve, active calibration curve, known alpha, and add-a-source. The calibration procedures for the other analysis methods are not as simple and are not part of the INCC program.

The add-a-source calibration is used to get calibration data for the doubles rate from the item versus the effective ^{240}Pu mass of the item. You must get the calibration coefficients for the add-a-source correction factor outside this program.

Be certain that the measurement (detector) parameters are set the way you want them in *Setup / Measurement Parameters* because the calibration results depend on these parameters, and you must use the same parameters for the verification measurements.

In addition, if you want to do calibration measurements using the known alpha method, you must enter the alpha weight and the rho-zero values in *Maintain / Calibration / Known Alpha*.

11. Select the "OK" button and the calibration measurement will start.
12. You can end the measurement early, if desired, by selecting "Quit measurement with results" or "Abort measurement" button. If you choose the quit option, the results will be calculated with the data from the cycles completed so far. If you choose the abort option all the data from the current measurement will be destroyed.
13. When the measurement is finished, you will get two results windows, one for the cycle data and one for the final results. The last ten results windows will stay on the screen unless you close them manually. Final results are produced for each analysis method selected. For the active calibration curve method, the results are the doubles rate and standard deviation. For the passive calibration curve and add-a-source methods, the results are the effective ^{240}Pu mass and the doubles rate with its standard deviation. For the known alpha method, the results are the effective ^{240}Pu mass and the doubles rate, with its standard deviation, corrected for multiplication .

Calibration Procedure

1. Select *Maintain / Calibration / Deming Curve Fitting*.
2. Select the material type for which you want to generate a calibration curve.
3. Select the analysis method you want to use. If you want to use more than one analysis method, you must repeat this procedure for each analysis method.

4. Select the "OK" button.
5. For all analysis methods except known alpha, select the curve type you want to use. The choices are:

$$D = a + bm + cm^2 + dm^3$$

$$D = am^b$$

$$D = am/(1 + bm)$$

$$D = a(1 - e^{-bm})$$

Where D is the doubles rate, m is the mass, and a, b, c, and d are calibration coefficients.

The known alpha method always uses the curve type: $D = a + bm$

6. Select the "OK" button. You will get a list of all calibration measurements made with the material type and analysis method you selected.
7. Click on each measurement that you want to include in the curve fit. Select the "OK" button and you will get the Deming curve fitting program with the calibration data sets already loaded.
8. Do the least squares fit to your data. If needed, see the Deming user's manual or Deming online help for instructions.
9. Select the "OK" button and the calibration parameters will be transferred to the INCC program.
10. Check that the transfer of the calibration parameters was successful: select the appropriate analysis method under *Maintain / Calibration* and observe the calibration parameters.

Holdup Measurements

1. With INCC in maintenance mode select *Maintain / Glovebox Add/Edit/Delete* and enter the number of measurement positions for the glovebox to be assayed.
2. Set the passive background rates to zero. Background corrections are usually not made with holdup measurements.
3. Select *Acquire / Holdup*.
4. Select a glovebox id, an MBA, a stratum id, and the item material type.
5. Select an item id from the drop down list or type in a new item id. If the item id is new, the isotopics dialog box will appear. Enter the isotopics for the item being assayed at this time.
6. If you want to do a verification measurement, that is, if you want to compare the assay mass with a declared mass, enter the declared mass. Otherwise, enter zero for the declared mass.

7. Type in any comment you want to make.
8. Enter the count time per cycle in seconds and the number of cycles.
9. Select “Shift register” as the data source.
10. Select quality control (QC) tests on, that is, check the box.
11. Check the print box if you want printed results at the end of the measurement. You can always print results later under *Report / Holdup* if you do not want to print now.
12. Check the ending comment box if you want to be able to add a description of the measurement when it has completed.
13. Select the “Isotopics” button and enter the isotopic composition for your item if it has not already been entered.
14. Select the “OK” button, and the holdup measurement position screen will be displayed.
15. Click on the box that corresponds to the location of the detector relative to the glovebox. The selected box will change color and display the message “Measure Next”. Select the “Measure selected glovebox position” button and the measurement will begin. When the measurement for the position starts, a single results window is displayed showing the cycle data at this position. You can end the measurement early, if desired, by selecting “Quit measurement with results” or “Abort measurement” button. If you choose the quit option, the measurement will stop with the data from the cycles completed so far. If you choose the abort option the data from the current measurement position will be destroyed.
16. Once the measurement finishes, move the detector to the next location and select the next position to be measured in the software. Repeat this process until all the positions are measured. A cycle results window is generated for every position measured or remeasured.
17. A previously measured position can be remeasured by clicking on the box that corresponds to the location to be remeasured and selecting the “Measure selected glovebox position” button. The new data will replace the old data in the analysis.
18. Once all the positions have been measured, select the “Quit measurements with results” button on the measurement position screen. A final results window is opened showing all the count rate results from the individual measurement positions, the calculated average count rates for the whole glovebox, and assay mass and standard deviation for each analysis method that you selected. In addition, if you entered a declared mass, you will get a comparison between the assay and declared mass for each analysis method that you selected. If the “Abort measurement” button is selected, all the data for the entire glovebox will be destroyed.

Import Operator Declarations from Operator Review and Measurements from Radiation Review

INCC can calculate the mass and display results for verification measurement data files, and display results for background and normalization measurement data files imported from Radiation Review. These files were created from measurements made by Shift Register Collect or Multi-Instrument Collect running in unattended mode. These results will remain in the database, and can be reviewed or reanalyzed at any time, just as you would with any other measurement. The results from background and normalization measurements will replace previously existing values in the database and should be used with caution.

The measurement data files created by Radiation Review must reside in the common database directory. The format of these binary files is described in “Radiation Review Measurement Data File format” under the Input Files section of this document.

Each file includes all the cycles for one verification, background or normalization measurement. Note: All cycles in a verification or normalization measurement must have the same count time. Background measurements may have cycles with different count times because all the cycles will be summed into one cycle.

Import procedure:

1. The INCC import function is initiated by Integrated Review.
2. The operator declaration file created by Operator Review for INCC is read. Isotopic data sets are created for each unique set of isotopics and an entry is made in the item data entry table for each unique item id. Composite isotopics cannot be created from multiple sets of isotopics. This file contains the following parameters:

Material balance area
Item id
Stratum id
Inventory change code
I/O code
Material type
Declared mass (g)
Isotopics source code
Isotopics id
 ^{238}Pu %
 ^{239}Pu %
 ^{240}Pu %
 ^{241}Pu %
 ^{242}Pu %

Pu date (YYYYMMDD)

²⁴¹Am %

Am date (YYYYMMDD)

²³⁸Pu error

²³⁹Pu error

²⁴⁰Pu error

²⁴¹Pu error

²⁴²Pu error

²⁴¹Am error

3. The header for each Radiation Review file in the common database directory with an extension of .NCC is read. The files are sorted chronologically.
4. If no detector id has been created for a measurement, a warning message is displayed, and that measurement is skipped. In other words, **you must go into INCC and create the detector before you import any measurements from that detector**. This is necessary because there are several detector parameters such as gate length, dead time, efficiency ,etc. and calibration parameters that are needed to calculate mass.
5. Each measurement that passes step 4 is displayed in chronological order, one line per measurement, in a selection screen with the following information:

Detector id	Item id	Meas. Type	Date	Time	Filename
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6. The user selects as many measurements as desired, and they are processed in chronological order. The default is to select all measurements. The last processed background and normalization measurements will be saved in the database and used with subsequent verification measurements.
7. At this point there are two options. If the detector dependent “auto import” box was **not** checked, as each measurement is processed, the appropriate acquire dialog box is displayed, enabling the user to specify the desired details for that measurement. Steps 7, 8 and 9 only apply if “Auto import” was not checked.

Background measurements

Enter a comment if desired

From a checkbox select to use or not use QC tests

From a checkbox select to print or not print results

From a checkbox select to enter or not enter an ending comment

From a separate dialog box choose whether this is a passive or active measurement

Normalization measurements

Enter a comment if desired

From a checkbox select to use or not use QC tests

From a checkbox select to print or not print results

From a checkbox select to enter or not enter an ending comment

Source id (display only)

Verification measurements

Select Material Balance Area (defaults to current MBA)

Select or enter Item Id (defaults to the one in the file header)

Select Stratum Id (defaults to one corresponding to the item id in the file header if previously set through the *Item Data Entry* dialog box)

Select Material Type (defaults to the one corresponding to the item id in the file header if previously set through the *Item Data Entry* dialog box)

Enter declared mass (defaults to the one corresponding to the item id in the file header if previously set through the *Item Data Entry* dialog box)

Select Inventory Change Code (defaults to the one corresponding to the item id in the file header if previously set through the *Item Data Entry* dialog box)

Select I/O Code (defaults to the one corresponding to the item id in the file header if previously set through the *Item Data Entry* dialog box)

Select isotopics or composite isotopics by clicking on the button (defaults to the one corresponding to the item id in the file header if previously set through the *Item Data Entry* dialog box)

Enter a comment if desired

From a checkbox select to use or not use QC tests

From a checkbox select to print or not print results

From a checkbox select to enter or not enter an ending comment

If the “Auto import” checkbox has been checked, then as each measurement is processed only the dialog box for selecting active or passive is displayed for background measurements, no dialog boxes are displayed for normalization measurements, and if the item data for the item id of the current measurement have been previously entered then no dialog boxes are displayed for verification measurements. The “Auto import” checkbox is accessible in maintenance mode by selecting *Maintain | Unattended Measurements Setup*.

8. In manual mode a results text window is optionally printed for each selected measurement in the same format as for other measurements. The data source will be “Review disk file”.
9. In manual mode, if ‘Ending comment’ was selected then a dialog box will be displayed with the measurement results and a box for entering the ending comment.
10. If this is a verification measurement then the following data for this measurement will be appended to the file for Integrated Review to reconcile and display:

Pass/Fail status (pass specified as green, fail specified as yellow)

Detector id

Item id

Measurement start date and time

Calculated mass (g) from the primary analysis method

Calculated mass error

Declared - assay mass (g)

Declared - assay mass (%)
Isotopics source code

11. The import files created by Operator Review and Radiation Review for INCC will be deleted so that these operator declarations and measurements will not get imported again the next time there is an import.
12. When all measurement files have been processed INCC will exit.

Display measurement corresponding to a peak in Radiation Review

If the measurement has previously been imported, INCC can display the results for the verification measurement corresponding to a click on or near a peak on a graph in Radiation Review which will cause a data matching message to be sent to INCC. Any other installed review tool may also request the display of a verification measurement by using the data matching message.

When a data matching message is received from another review tool, usually Radiation Review, INCC displays the verification measurement for the detector specified in the data matching message that most closely matches the requested date and time according to the following algorithm:

If the requested date and time falls within the time interval of a verification measurement, that measurement will be displayed. The duration of a measurement is defined as the beginning of the first cycle through the end of the last cycle.

Otherwise the date and time of the end of the preceding measurement and the beginning of the following measurement are compared. Whichever is closest to the requested date and time will be displayed unless:

The time difference between the requested date and time and the measurement date and time exceeds the maximum time specified by a parameter that can be entered from the “Unattended Measurement Parameters” dialog box. If this time difference is exceeded then a message will be displayed indicating no match was found for the requested verification measurement date and time.

An error message will be displayed if there are no verification measurements for the requested detector.

The INCC standard menu (operator mode) will be displayed when processing has completed. All functions that are available in standalone mode will now be available.

The requested verification measurement will be displayed in a text window and printed if print was selected the last time a measurement result was displayed.

NOTE: INCC always assumes the currently selected facility. If you want to import files from a different facility, you must first go into INCC and select (first create if it does not already exist) the desired facility.

Operations Reference

Startup

To start INCC using a Windows 95 type user interface, click on Start, then click on Programs, then click on the INCC 3.20 file folder and then click on the INCC 3.20 icon.

Inspection Main Menu

The major software controls, as listed below, are usually referred to as the Main Menu. The following are provided by INCC when in Inspection mode:

File

Contains options for exporting PSA, Logsheet and Performance Monitoring files, importing Stratum Authority and Item Relevant Data from files, transfer of measurement files, backing up and restoring the entire database, printer setup and program exit.

View

Provides the ability to switch between Inspection and Maintenance modes.

Setup

Contains options for facility, inspection, measurement parameter, isotopics, composite isotopics, item data and collar data entry.

Acquire

Contains rates only, background, normalization, verification and holdup measurement data acquisition methods.

Reanalyze

Contains options for reanalyzing verification and holdup measurements with selected parameters changed.

Report

Contains all options for review and reporting of previously acquired measurement data and an option to plot measurement data with their calibration curve.

Tools

Contains an option providing the user with the ability to have Radiation Review display the peak corresponding to the most recently displayed INCC verification measurement.

Window

Contains options for arranging measurement data windows.

Help

Contains online help and information about copyright restrictions and the date and version number of INCC being used.

Maintenance Main Menu

The major software controls, as listed below, are usually referred to as the Main Menu. The following are provided by INCC when in Maintenance mode:

File

Contains options for exporting PSA, Logsheet and Performance Monitoring files, importing Stratum Authority and Item Relevant Data from files, transfer of measurement files, saving and restoring measurement (detector) parameters and calibration parameters (initial data), backing up and restoring the entire database, printer setup and program exit.

View

Provides the ability to switch between Inspection and Maintenance modes.

Setup

Contains options for facility, inspection, measurement parameter, isotopics, composite isotopics, item data and collar data entry.

Maintain

Contains all other parameter entry and setup, including calibration, background, normalization, measurements acquired in unattended mode, QC, stratum rejection limits, error calculation method, archive, and add-a-source. Contains options for adding and deleting detectors, facilities, material balance areas, strata, material types, poison rod types and gloveboxes. Provides a way of deleting unwanted measurements from the database.

Acquire

Contains all measurement data acquisition methods.

Reanalyze

Contains options for reanalyzing verification and holdup measurements with selected parameters changed.

Report

Contains all options for review and reporting of previously acquired measurement data and an option to plot measurement data with their calibration curve.

Tools

Contains an option providing the user with the ability to have Radiation Review display the peak corresponding to the most recently displayed INCC verification measurement.

Window

Contains options for arranging measurement data windows.

Help

Contains online help and information about copyright restrictions and the date and version number of INCC being used.

File Submenu

Contains options for exporting PSA, Logsheet and Performance Monitoring files, importing Stratum Authority and Item Relevant Data from files, transfer of measurement files, saving and restoring measurement (detector) parameters and calibration parameters (initial data), backing up and restoring the entire database, printer setup, and program exit.

Measurement and calibration parameters can only be saved and restored in Maintenance mode. Printer setup is only available in maintenance mode.

Save As/Export

File / Save As/Export / PSA/Logsheet File provides a way of exporting data to the PSA Operator-Inspector Measurement Database. The user will be prompted to type in the disk drive, path and file name. The default file name is NCC_PSA.dat.

File / Save As/Export / Performance Monitoring File provides a way of exporting Performance Monitoring data which includes information about normalization measurements. The user will be prompted to type in the disk drive, path and file name. The default file name is NCC_perf.dat.

File / Save As/Export / Transfer provides a way to save measurement data sets on a disk and later restore them either on the same computer or another computer running INCC. The measurement data sets are written in a binary format that INCC can read using *File / Get External Data / Transfer* which is a complementary function. Through a dialog box with radio buttons you must next select whether to save measurements only from the current detector or all detectors. If the current detector is chosen, you will then be asked to select an inspection number. In either case, you will be prompted to type in the disk drive and path where the measurement data are to be written. For the inspection number, select "All" to be able to choose from all measurements of any type; otherwise select the desired verification measurement inspection number. You will then be able to select which measurement data sets are to be saved. Click on a line to select that measurement data set. Selected lines will be highlighted in blue.

File / Save As/Export / Initial Data provides a way to save measurement (detector) parameters and calibration parameters on a disk and later restore them either on the same computer or another computer running INCC. The parameters are written in a binary format that INCC can read using *File / Get External Data / Initial Data* which is a complementary function. Measurement and calibration parameters can only be saved and restored in Maintenance mode. You must next select which type of parameters to save. There will be a dialog box with radio buttons for "Save detector parameters for the current detector", "Save detector parameters for all detectors" "Save calibration parameters for the current detector" and "Save calibration parameters for all detectors". You will be prompted to type in the disk drive and path where the parameters are to be written. Select the "OK" button to cause the selected parameter sets to be written to disk files.

Get External Data

File / Get External Data / Stratum Authority File provides a way of importing stratum ids and historical bias, random uncertainty and systematic uncertainty. The user will first be prompted to select a file name using the Windows standard file selection process. The default file name is NCCstrat.dat. The file will be read in as soon as you select "OK" after selecting a file. New facilities and strata will automatically be created if necessary. Already existing strata will automatically be overwritten.

File / Get External Data / Item Relevant Data File provides a way of importing item ids and all the parameters associated with an item. This information will typically come from IFSS, SPAN or NMAX. The user will first be prompted to select a file name using the Windows standard file selection process. The default file name is NCC_PSA.dat. The file will be read in as soon as you select "OK" after selecting a file. New facilities, MBAs, strata, inventory change codes, I/O codes, material types, isotopics, collar data and item ids will automatically be created if necessary. Already existing items will automatically be overwritten.

File / Get External Data / Transfer provides a way to restore measurement data previously saved on a disk. *Transfer* may be used on either on the same computer where the data were saved or another

computer running INCC. The data must have been written in a binary format using *File / Save As/Export / Transfer*. The user will be prompted to type in the disk drive and path from where the measurement data are to be read. The user will then be able to select which measurement data sets are to be restored. Click on a line to select that measurement data set. Selected lines will be highlighted in blue. The selected files will be read in as soon as you select “OK”.

File / Get External Data / Initial Data provides a way to restore measurement (detector) parameters and calibration parameters. The user will select the desired file from the standard windows file selection dialog box. Only one set of detector or calibration parameters can be restored at a time. A set will include all of the detector or calibration parameters for a particular detector. The selected file will be read in as soon as you select “OK”.

Warning: there is only one set of measurement (detector) parameters, and one set of calibration parameters for each material type and analysis method. Restoring detector or calibration parameters will overwrite your existing parameters.

Backup All Data

File / Backup All Data provides a way of saving the entire database to a disk file in zip (compacted) format. The user will be prompted to type in the disk drive and path where the database is to be saved. As soon as you select “OK” the database will be written file by file using the pkzip utility. You will be notified when the backup has completed.

Restore All Data

File / Restore All Data provides a way of restoring the entire database from a zipped (compacted) disk file created using *File / Backup All Data*. The user will be prompted to type in the disk drive and path from where the database is to be restored. **As soon as you select “OK” the existing database will be overwritten file by file using the pkunzip utility.** You will be notified when the restore has completed.

Printer Setup

To use this feature, select *File / Printer Setup*. *Printer Setup* provides the user with a means of configuring the printer, such as selecting between portrait and landscape mode. This is the standard windows Print Manager, Printer Setup screen.

Exit INCC

Selecting *File / Exit INCC* is one way of exiting the INCC program. Clicking on the System menu button and then selecting Close will also cause INCC to exit.

View Submenu

View / Maintain provides the ability to switch between Inspection and Maintenance modes. Clicking on *View / Maintain* toggles between the two modes. A check mark by *Maintain* indicates that you are in Maintenance mode.

Setup Submenu

Contains options for setting up facility and general inspection parameters, measurement (detector) parameters, isotopics, composite isotopics, item data and collar item data. Isotopics, composite isotopics, item data and collar item data can be entered while acquiring measurement data from the shift register.

Facility/Inspection

Setup / Facility/Inspection provides a dialog box for selecting the facility, material balance area and detector id. When the detector id is selected the detector type and electronics id will also be selected, but may be changed here if necessary. The three digit inspection number and inspector name are also entered here. There is a button that will allow you to change the system date, time and time zone.

The amount of information included in results displays and printouts is controlled here by a series of check boxes. Listed below are the choices and their default values. Selected values remain in effect until specifically changed here or in one of the report dialog boxes.

Detector parameters	On
Calibration parameters	On
Isotopics	On
Individual cycle raw data	Off
Individual cycle rate data	On
Summed raw coincidence data	Off
Summed multiplicity distributions	Off
Individual multiplicity distributions	Off

All measurement data sets are written to an ASCII file created using the file naming convention described in “File naming conventions”. The default directory for these files is `\INCC_310\DATA`. The “Change ASCII results data directory” button allows the user to specify a different directory, for example a Jaz drive, so that the measurement data files can be taken to a different computer. The

archive subdirectory will automatically be created. For more about the data and archive subdirectories, see "Archive". The user will be presented with a dialog box for typing in the disk drive and path for writing ASCII measurement data files.

Measurement Parameters

To use this feature, select *Setup / Measurement Parameters*. You must select the shift register type that matches the electronics used in your system. The choices are MSR4 or 2150, JSR-11, JSR-12, PSR or ISR and DGSR. MSR4 refers to the Los Alamos prototype multiplicity shift register nuclear instrument module and the commercial version of the circuit, the Canberra model 2150. The JSR-11 and JSR-12 are Canberra coincidence electronics packages that do not have multiplicity electronics. The PSR is the Los Alamos and Aquila portable shift register that has multiplicity electronics. The DGSR is the Los Alamos prototype portable shift register that utilizes two gates to decrease the statistical error, thereby reducing the count time required to achieve the same precision with a single gate.

Depending on which shift register type you select, in Inspection mode some of the parameters will be grayed out in this dialog box to indicate that they cannot be set from the computer by the shift register type selected. The parameters are not grayed out in Maintenance mode so that you can enter the correct values for display.

The serial port that connects the computer to the coincidence electronics can vary from system to system. You must select the port that matches the configuration of your system. The choices are COM1 and COM2. In simple systems the shift register port is usually COM1.

The predelay can be set from 0 to 1023.75 microseconds in 0.25 microsecond steps. The usual predelay is 4.5 microseconds for conventional coincidence counting and 3 microseconds for multiplicity counting.

The gate length can be set from 0.25 to 1024 microseconds in 0.25 microsecond steps. The most common gate length is 64 microseconds for conventional coincidence counting and 32 microseconds for multiplicity counting. The second gate length applies only to the DGSR, and functions the same as the first gate length.

The most common high voltage is 1680 volts. A recommended value should be given in the detector manual or indicated with a label at the high voltage connector of the detector.

The die-away time depends on the detector design and is typically 40 to 70 microseconds. The detector manual usually gives the value. If you cannot determine the die-away time, use 50 microseconds.

The singles rates are corrected with a deadtime, where S is the measured singles rate, and A is the deadtime coefficient. The doubles rates are corrected with a deadtime, where D is the measured doubles rate, and B is the deadtime coefficient. See the detector manual for values of A and B. Deadtime coefficient A is given in units of microseconds and B is given in units of microseconds squared.

The neutron detection efficiency is typically 0.15 to 0.60. See the detector manual for the value or measure it using a calibrated ^{252}Cf source.

The multiplicity deadtime is used to correct the triples counting rate. Its value is typically 30 to 200 nanoseconds. See the detector manual for the deadtime value.

The deadtime coefficients A and B are used to correct the singles and doubles rates. For a six-channel Amptek system, A is typically 0.6 to 0.8 μs and B is typically 0.20 to 0.26 $(\mu\text{s})^2$. See the detector manual for the deadtime values.

The deadtime coefficient C is used for an additional deadtime correction factor for the triples rate. The value for C is typically 0 to $1 * 10^{-7}$ seconds. Get the value for C from the detector manual, if specified. Otherwise, set $C = 0$.

The doubles gate fraction accounts for the effect of the finite length of the coincidence gate on the doubles rate. The doubles gate fraction is typically about 0.4. Get the value from the detector manual.

The triples gate fraction accounts for the effect of the finite length of the coincidence gate on the triples rate. The triples gate fraction is approximately the square of the doubles gate fraction. Get the value from the detector manual.

The efficiency, multiplicity deadtime, doubles gate fraction, and triples gate fraction are used only for multiplicity analysis and can be ignored for conventional coincidence counting.

Isotopics

To use this feature, select *Setup / Isotopics*. The plutonium isotopic composition of the verification item can either be entered from the keyboard or read in from a disk file by using the "Read isotopics from file" button. Enter the ^{241}Am content as the weight percent of the total plutonium. Enter isotopics errors as the weight percent of the total plutonium.

If you use a disk file for the plutonium isotopic composition, the file must first contain the isotopics id, then the isotopics source code, and then the isotopic data in the same order as shown in the dialog box, with the errors at the end. The dates must be in the format chosen for your windows system.

You can change the date format through the control panel by clicking on the “Regional settings” icon. The disk file must be a text (ASCII) file, with the data elements separated by commas. If the isotopics id contains spaces, it must be enclosed in double quotes. For a complete description of the isotopics file format, see "Isotopics data file format".

The possible isotopics source codes are:

OD	Operator declared
IA	Inspector analyzed
IM	Inspector measured
OA	Operator analyzed
OC	Operator calculated
OE	Operator estimated
OS	Other source
CO	Composite

If the isotopics source code is CO, all the isotopic composition values and dates will be grayed out because composite isotopics can only be changed by selecting *Setup / Composite Isotopics*. Selecting the "Add isotopics data set" button, and then typing in the isotopics id in the dialog box that will appear will allow you to enter a new set of isotopics even if the previously displayed isotopics were grayed out because the isotopics source code was CO.

Multiple isotopic data sets may be stored in the database simultaneously, and a particular set may be selected by its isotopics id. The selected isotopics data set will be used by all verifications until another one is selected. An isotopics data set may be written to a disk file by selecting the "Write isotopics to file" button, and then typing in the disk drive letter, full path and file name in the dialog box that will appear. A new isotopics data set may be created by typing in the desired isotopics values, then selecting the "Add isotopics data set" button, and then typing in the isotopics id in the dialog box that will appear. The isotopics values for an already existing isotopics data set may be changed by selecting the desired isotopics id, typing in the new values, and then selecting the "Save isotopics data set" button. The isotopics id for an existing isotopics data set may be changed by selecting the desired isotopics id, selecting the "Edit isotopics id" button, and then typing in the new isotopics id in the dialog box that will appear. An isotopics data set may be deleted from the database by selecting the desired isotopics id and then selecting the "Delete isotopics data set" button. This will be necessary when the maximum of 1000 isotopics data sets is reached.

Composite Isotopics

To use this feature, select *Setup / Composite Isotopics*. The composite plutonium isotopic composition, consisting of up to 20 sets of isotopics, for the verification item can either be entered from the keyboard or read in from a disk file. Enter the ^{241}Am content as weight percent of plutonium. When you have all the isotopic compositions entered correctly, select the "Calculate and

Store Isotopics" button. This will cause the composite isotopics, weighted by mass, to be calculated and stored in the isotopics database using the composite isotopics id. Only isotopic compositions with a mass greater than zero will be included in the composite isotopics calculation. The composite isotopic composition is weighted by mass. If you forget to select the "Calculate and Store Isotopics" button, you will be reminded when you select OK to exit the composite isotopics dialog box.

If you use a disk file for the composite plutonium isotopic composition, the file must contain first the composite isotopics id, then the mass in grams Pu, and then the isotopic data in the same order as shown in the dialog box, with the errors at the end. Repeat the mass, isotopic data and errors for each set that makes up the isotopic composition. The dates must be in the format chosen for your windows system. You can change the date format through the control panel by clicking on the "Regional settings" icon. The disk file must be a text (ASCII) file, with the data elements separated by commas. If the composite isotopics id contains spaces, it must be enclosed in double quotes. For a complete description of the composite isotopics file format, see "Composite isotopics data file format".

Multiple composite isotopic data sets may be stored in the database simultaneously, and a particular one may be selected by its composite isotopics id. A composite isotopics data set may be written to a disk file by selecting the "Write composite isotopics to file" button, and then typing in the disk drive letter, full path and file name in the dialog box that will appear. A new composite isotopics data set may be created by typing in the desired composite isotopics values, then selecting the "Add composite isotopics data set" button, and then typing in the composite isotopics id in the dialog box that will appear. The composite isotopics values for an already existing composite isotopics data set may be changed by selecting the desired composite isotopics id, typing in the new values, and then selecting the "Save composite isotopics data set" button. The composite isotopics id for an existing composite isotopics data set may be changed by selecting the desired composite isotopics id, selecting the "Edit composite isotopics id" button, and then typing in the new composite isotopics id in the dialog box that will appear. A composite isotopics data set may be deleted from the database by selecting the desired composite isotopics id and then selecting the "Delete composite isotopics data set" button. This will be necessary when the maximum of 1000 composite isotopics data sets is reached.

Item Data Entry

To use this feature, select *Setup / Item Data Entry*. You can enter item ids to be measured, along with their material balance area, material type, isotopics, stratum id, inventory change code, I/O code and declared mass. You can only select a material type, isotopics id and stratum id from a drop down list. Therefore, you must have already entered the desired material types from the *Material Type Add/Delete* dialog box, the desired isotopics from the *Isotopics* dialog box and the desired stratum ids from *Stratum id Add/Delete* dialog box. You may also enter item from a disk file through the *File / Get External Data / Item Relevant Data File* option.

The possible values for the Inventory change code are:

Blank field	PIV or IIV
RD	Received during interim (domestic)
RF	Received during interim (foreign)
RN	Received during interim
SD	Shipped/measured during interim inspection (domestic)
SF	Shipped/measured during interim inspection (foreign)
SN	Shipped/measured during interim inspection

The possible values for the I/O code are:

Blank field	PIV
X	IIV
I	Received during interim
A	Received/measured during PIV and before PIV date
C	Received/measured during PIV and after PIV date
O	Shipped/measured during interim inspection
B	Shipped/measured during PIV and before PIV date
D	Shipped/measured during PIV and after PIV date
F	Flow measurement
T	Test measurement
Z	Other

Collar Item Data Entry

To use this feature, select *Setup / Collar Item Data Entry*. You can enter collar item ids to be measured, along with their rod length, rod length error, total ^{235}U , total ^{235}U error, total ^{238}U , total ^{238}U error, total number of rods, total number of poison rods, poison percent, poison percent error and poison rod type. You can only select a poison rod type. Therefore, you must have already entered the desired poison rod type from *Poison Rod Type Add/Delete*. For each collar item you must also have used *Item Data Entry* to create a corresponding entry.

Maintain Submenu

The *Maintain* submenu is only available in Maintenance mode. It contains options for setting up calibration, background, normalization, QC and test parameters, stratum rejection limits, error calculation method, archive parameters and add-a-source parameters. It also provides the ability to add and delete detectors, facilities, material balance areas, strata, material types, poison rod types and gloveboxes. Finally, it provides a way of deleting unwanted measurements from the database.

Calibration

Calibration contains calibration parameter edit options for each analysis method, and an option to call the Deming Curve Fitting program to calculate and automatically store calibration parameters in the INCC database.

Deming Curve Fitting

To use this feature, select *Maintain / Calibration / Deming Curve Fitting*. You can fit your calibration data with the Deming least squares fitting program starting from this dialog box. First select the material type and the analysis method for which you want to obtain calibration parameters. If you want to verify items of a certain type using more than one analysis method, you must determine the calibration parameters for each analysis method separately. Calibration for multiplicity, active/passive, or known multiplication analysis is more complex than fitting a curve, and cannot be done within this program.

After you select the "OK" button you will get a list of calibration measurement data sets for the material type and analysis method you chose. Select the data sets you want to include in the least squares fit and then select the "OK" button. This program will now start the Deming least squares fitting program and load your data sets. Do the least squares fit using a function appropriate for the selected analysis method. See the Deming user's manual or Deming online help for information on the Deming code. When you are finished with the Deming fit, the calibration parameters will be automatically installed in the INCC database, and you will be returned to this program. You can check the results by selecting your analysis method under *Maintain / Calibration* and then selecting your material type. The calibration parameters obtained from the Deming program should be displayed in the dialog box.

Analysis Methods

To use this feature, select *Maintain / Calibration / Analysis Methods*. A set of verification measurement data can be analyzed with many different analysis methods. Seven passive methods (calibration curve, known alpha, known M, multiplicity add-a-source, curium ratio and truncated multiplicity) and four active methods (calibration curve, collar, multiplicity and active/passive) are provided. For each material type that you will verify, select the analysis methods you want to use by clicking in their boxes. Except for collar, any material type can be analyzed with one or more analysis methods.

You will get as many results sets as you have selected analysis methods. For passive verification measurements there is an automatic comparison of different analysis methods when two or more have been selected. The accepted verification result will be the "normal" method unless the result

from the “backup” method differs by more than n standard deviations from the normal method, where n is a test parameter that can be set by selecting *Maintain / QC and Test Parameters*. If the two methods differ by more than the test limit then the backup result is accepted. The accepted result will be highlighted. If a user selects two or more passive analysis methods an additional dialog box will be displayed for the user to select one “normal” and one “backup” analysis method.

For each material type and analysis method you select, you must enter appropriate calibration parameters under *Maintain / Calibration* in the main menu.

Passive Calibration Curve

To use this analysis method select *Maintain / Calibration / Passive Calibration Curve*. There is a calibration parameter set for each material type. A set consists of the upper and lower mass limits, the curve type, the coefficients, the variances, the covariances, and an extra error term (sigma x).

The curve types are:

1. $D = a + bm + cm^2 + dm^3$
2. $D = am^b$
3. $D = am/(1 + bm)$
4. $D = a(1 - e^{-bm})$

Where D is the doubles rate, m is the mass of effective ^{240}Pu or ^{235}U , and a, b, c, and d are calibration coefficients.

You can enter the parameters from the keyboard or use the Deming code to enter the parameters automatically. The extra error term (sigma x) is always zero unless you change it from the keyboard. This error is used to account for extra error sources, for example, error sources not accounted for by the curve fitting process. The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The polynomial curve type can have more than one solution for a specified doubles rate. In this case the software selects the smallest mass that is within the upper and lower mass limits. If there is no solution within the mass limits, then the software selects the smallest positive mass. If there is no positive mass, then the least negative mass is selected.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Known Alpha

To use this analysis method select *Maintain / Calibration / Known Alpha*. There is a calibration parameter set for each material type. A set consists of the alpha weight, the rho-zero value, the extra error term (sigma x), and the coefficients a and b, their variances and covariance:

$$D = a + bm$$

Where D is the doubles rate corrected for multiplication and m is the effective ²⁴⁰Pu mass.

The alpha value is the ratio of neutrons from (alpha, n) reactions to neutrons from spontaneous fissions. For pure plutonium metal, alpha is zero because there are no (alpha, n) reactions. For pure plutonium oxide, alpha can be calculated from the plutonium isotopic composition because the (alpha, n) yield for oxygen is known for each of the plutonium isotopes. This calculation is performed by the software. The alpha value used for the multiplication-correction calculation is the alpha value for pure plutonium oxide multiplied by a weighting factor called the alpha weight. For pure plutonium metal the alpha weight is zero, For pure plutonium oxide, the alpha weight is one. If items have uniform impurities that change the alpha value for pure oxide by a known amount, the alpha value for these items can be calculated by using the appropriate alpha weight.

Rho-zero is the ratio of the doubles to singles rates times $(1 + k)$ for a nonmultiplying item of ²⁴⁰Pu. Rho-zero is used as a reference value for the multiplication correction calculation. It depends on the detector parameters. Get the recommended value for rho-zero from the user's manual for the detector.

You can enter the calibration coefficients a and b and their variances and covariance from the keyboard or use the Deming code to enter the values automatically. The alpha weight, rho-zero, and the extra error term (sigma x) must be entered from the keyboard. The extra error term (sigma x) is always zero unless you change it from the keyboard. This error is used to account for extra error sources, for example, error sources not accounted for by the curve fitting process. The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The constant k is used in the equation that determines the neutron multiplication. It depends on the moments of the spontaneous fission neutron distributions of ²⁴⁰Pu and on the induced fission neutron distributions of ²³⁹Pu. The default value is 2.166.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Known M

To use this analysis method select *Maintain / Calibration / Known M*. There is a calibration parameter set for each material type. A set consists of five nuclear data constants, calibration coefficients b and c, and the excess error, sigma(x). You will probably not need to change the nuclear constants from their default values:

Spontaneous fission rate of ²⁴⁰ Pu (fissions/g/s):	473.5
1st factorial moment of ²⁴⁰ Pu spontaneous fission neutron distribution:	2.154
2nd factorial moment of ²⁴⁰ Pu spontaneous fission neutron distribution:	5.789
1st factorial moment of ²³⁹ Pu 2-MeV induced fission neutron distribution:	3.163
2nd factorial moment of ²³⁹ Pu 2-MeV induced fission neutron distribution:	8.240

The calibration coefficients b and c relate the neutron multiplication (M) to the effective ²³⁹Pu mass (m) through the calibration equation:

$$M = 1 + bm + cm^2$$

All parameters must be entered from the keyboard. The calibration of M versus m must be done outside this program. The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Passive Multiplicity

To use this analysis method select *Maintain / Calibration / Passive Multiplicity*. There is a calibration parameter set for each material type. A set consists of seven nuclear data constants, three calibration coefficients (a, b, c), and the excess error, sigma(x). You will probably not need to change the nuclear constants from their default values:

Spontaneous fission rate of ²⁴⁰ Pu (fissions/g/s):	473.5
1st factorial moment of ²⁴⁰ Pu spontaneous fission neutron distribution:	2.154
2nd factorial moment of ²⁴⁰ Pu spontaneous fission neutron distribution:	3.789
3rd factorial moment of ²⁴⁰ Pu spontaneous fission neutron distribution:	5.211

1st factorial moment of ^{239}Pu 2-MeV induced fission neutron distribution: 3.163

2nd factorial moment of ^{239}Pu 2-MeV induced fission neutron distribution: 8.240

3rd factorial moment of ^{239}Pu 2-MeV induced fission neutron distribution: 17.321

Coefficients a, b, and c determine a correction factor (CF1) for the effective ^{240}Pu assay mass that depends on the neutron multiplication (M) through the equation:

$$\text{CF1} = a + b(M - 1) + c(M - 1)^2$$

For no correction, set $a = 1$ and $b = c = 0$.

All parameters must be entered from the keyboard. The coefficients a, b and c must be determined outside this program. The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Add-a-source

To use this analysis method select *Maintain / Calibration / Add-a-source*. There is a calibration parameter set for each material type. The parameters for the add-a-source technique consist of parameters for the calibration of the doubles rate versus effective ^{240}Pu mass and parameters for the add-a-source correction. The parameters for the calibration of doubles rate versus effective ^{240}Pu mass have the same meaning as those used for the passive calibration curve method. The parameters for the add-a-source correction consist of the number of add-a-source cycles, the add-a-source correction coefficients, the add-a-source reference date, and the add-a-source reference rates.

The add-a-source measurement consists of the measurement of an item followed by the measurement of the item plus the add-a-source located at one to five positions in the assay chamber. The number of positions is set in the dialog box for "CompuMotor Setup" or "PLC Setup" under *Maintain / Add-a-source Setup*. The add-a-source parameter "Number of cycles" is the number of cycles for the add-a-source at each of the add-a-source positions.

The add-a-source correction factor (cf) for the doubles rate is:

$$\text{cf} = 1 + a + b \cdot \text{delta} + c \cdot \text{delta}^2 + d \cdot \text{delta}^3$$

Where a, b, c, and d are calibration coefficients and:

$$\text{delta} = r - 1$$

Where r is the ratio of the add-a-source reference doubles rate to the measured add-a-source doubles rate. The calibration coefficients a , b , c , and d must be determined outside this program.

The add-a-source reference doubles rate (D0 average) is the average of the reference doubles rates for up to five add-a-source positions. As you enter the reference doubles rates for the add-a-source positions, the average is displayed. You cannot enter the average directly. The add-a-source reference date (D0 reference date) is the date when the reference doubles rates were measured at the add-a-source positions.

The calibration coefficients for the passive calibration curve can be transferred automatically from the Deming program or can be entered from the keyboard. All add-a-source parameters must be entered from the keyboard. The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Curium Ratio

To use this analysis method select *Maintain / Calibration / Curium Ratio*. There is a calibration parameter set for each material type. A calibration parameter set consists of the curve type, coefficients, variances, covariances, an extra error term (σ_x), and a button choice for using either single or doubles rates for the analysis.

The curve types are:

1. $D = a + bm + cm^2 + dm^3$
2. $D = am^b$
3. $D = am/(1 + bm)$
4. $D = a(1 - e^{-bm})$

Where D is the count rate (doubles or singles, depending upon the selected button option), m is the mass of $^{244}\text{curium}$, and a , b , c , and d are calibration coefficients.

The parameters are entered from the keyboard. The extra error term (σ_x) is always zero unless you change it. This error is used to account for extra error sources, for example, error sources not

accounted for by the curve fitting process (errors in the facility supplied curium mass ratios are not entered here). The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the count rate standard deviation.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Truncated Multiplicity

The truncated multiplicity analysis method is used for the measurement of very small Pu items when the cosmic ray background interferes with the measurement. Truncated multiplicity analysis uses only the first three multiplicity values (the zeros, ones, and twos) in the multiplicity distributions and thus ignores the higher multiplicities that are produced primarily by cosmic rays; this improves the precision of the assay mass.

To use this analysis method, select *Maintain / Calibration / Truncated Multiplicity*. Each material type has its own set of parameters. The truncated multiplicity parameters are the two calibration coefficients (a and b) and the choice of analysis methods. The analysis can be done using the known efficiency method, the unknown efficiency method, or both. In the known efficiency method, the efficiency is taken from the measurement parameters for the detector (under *Setup / Measurement Parameters*). In the unknown efficiency method the efficiency is calculated from the measured twos/ones ratio. If you select both analysis methods, you will get two verification results; the software does not try to select the preferred result. However, if you select truncated multiplicity with other analysis methods, such as passive multiplicity or calibration curve, then only the known efficiency solution from truncated multiplicity analysis is used to determine the primary result.

The calibration coefficient 'a' is a correction factor for the measured ones rate in the known-efficiency solution. Select 'a' so that the assay mass is correct for a small Pu standard. The calibration coefficient 'b' is a correction factor for the measured ones rate in the unknown-efficiency solution. Select 'b' so that the assay mass is correct for a small Pu standard.

Active Calibration Curve

To use this analysis method select *Maintain / Calibration / Active Calibration Curve*. There is a calibration parameter set for each material type. A set consists of the curve type, the coefficients, the variances, the covariances, and an extra error term (σ_x).

The curve types are:

1. $D = a + bm + cm^2 + dm^3$
2. $D = am^b$
3. $D = am/(1 + bm)$
4. $D = a(1 - e^{-bm})$

Where D is the doubles rate, m is the mass of ^{235}U , and a, b, c, and d are calibration coefficients.

You can enter the parameters from the keyboard or use the Deming code to enter the parameters automatically. The extra error term (sigma x) is always zero unless you change it from the keyboard. This error is used to account for extra error sources, for example, error sources not accounted for by the curve fitting process. The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Collar

To use this analysis method select *Maintain / Calibration / Collar*. Then select the "Calibration coefficients" radio button. Select the material type (PWR, BWR, etc.) and the mode [Thermal (no Cd)] or [Fast (Cd)]. You can set upper and lower mass limits, if desired; after a verification measurement is completed, a warning is given if the assay mass is outside of the mass limits.

The only calibration curve type used for the collar so far is $D = am/(1 + bm)$, where D is the doubles rate, m is the U235 mass, and a and b are calibration coefficients. You can enter the calibration coefficients and errors from the keyboard or read them from a disk file under *File / Get External Data / Initial Data*. The extra error term (sigma x) is normally zero. This error is used to account for error sources not accounted for by the curve-fitting process and is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The number of calibration rods is the number of rods in the fuel assembly used to determine the calibration parameters.

The poison correction factor k3 has the form:

$$k3 = 1 + n * N0 / N * a * [1 - \exp(-\lambda * \text{poison})] * (b - c * E)$$

where:

n = number of poison rods in the measured fuel assembly
N0 = number of rods in reference fuel assembly
N = total number of rods in the measured fuel assembly
lambda = poison absorption factor
poison = weight-percent poison in the poison rods
E = U235 enrichment in percent
a, b, c = calibration constants.

Lambda depends on the type of poison rod. You can enter new poison rod types *under Maintain / Poison Rod Type Add/Delete*.

The uranium mass correction factor k4 has the form:

$$k4 = 1 + a * (b - U)$$

where:

U = total uranium mass in grams
a, b = calibration constants.

The extra-item correction factor k5 accounts for other sample effects such as protective bagging and cardboard around a fuel assembly.

You can find details about collar calibration in the Los Alamos report “Neutron Collar Calibration and Evaluation for Assay of LWR Fuel Assemblies Containing Burnable Neutron Absorbers”, LA-11965-MS (1990). This report gives calibration parameters for PWR and BWR fuel assemblies containing gadolinium poison rods.

You can print all of the collar calibration parameters by clicking on “Print calibration parameters” in either the “Collar Calibration” or “Correction Factors” dialog box.

Active Multiplicity

To use this analysis method select *Maintain / Calibration / Active Multiplicity*.

There is a set of calibration parameters for each material type. For active multiplicity verification the only quantity determined at present is the neutron multiplication; verification ²³⁵U mass is not determined. The neutron multiplication can be determined from the measured triples and doubles rates and six nuclear data constants. You will probably not need to change these constants from their default values:

1st factorial moment of thermal neutron induced fission of ²³⁵U: 2.414

2nd factorial moment of thermal neutron induced fission of ^{235}U :	4.638
3rd factorial moment of thermal neutron induced fission of ^{235}U :	6.818
1st factorial moment of fast neutron induced fission of ^{235}U :	2.637
2nd factorial moment of fast neutron induced fission of ^{235}U :	5.623
3rd factorial moment of fast neutron induced fission of ^{235}U :	9.476

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Active/Passive

To use this analysis method select *Maintain / Calibration / Active/Passive*.

The active/passive technique is used for the active verification of items which have a passive neutron yield. At present this technique simply subtracts the passive count rates from the active count rates and calculates the effective ^{235}U mass from the calibration curve.

There is a calibration parameter set for each material type. A set consists of the curve type, the coefficients, the variances, the covariances, and an extra error term (sigma x).

The curve types are:

1. $D = a + bm + cm^2 + dm^3$
2. $D = am^b$
3. $D = am/(1 + bm)$
4. $D = a(1 - e^{-bm})$

Where D is the doubles rate, m is the mass of effective ^{240}Pu or ^{235}U , and a, b, c, and d are calibration coefficients.

You can enter the parameters from the keyboard or use the Deming code to enter the parameters automatically. The extra error term (sigma x) is always zero unless you change it from the keyboard. This error is used to account for extra error sources, for example, error sources not accounted for by the curve fitting process. The extra error is expressed as percent relative standard deviation; the corresponding mass error is combined quadratically with the mass error calculated from the calibration curve variances and covariances and the doubles rate standard deviation.

The calibration parameters can be printed with the measurement (detector) parameters by selecting the "Print calibration parameters" button.

Background Setup

You can inspect and change the background count rates under *Maintain / Background Setup*. The background rates are the passive singles, doubles, and triples rates with errors (room background), the active background singles rate and error (AmLi source background), and the passive and active background rates in scaler 1 and scaler 2 (the extra scalers on the PSR, MSR4, and 2150 shift-register units). Normally you do not need to use the Background Setup option. After a background measurement is completed, the background rates are automatically stored.

Normalization Setup

There are three options under *Maintain / Normalization Setup*:

- Use Cf252 source for normalization test
- Use AmLi source for normalization test
- Collar normalization test

Normally AmLi is used for normalization measurements with active systems such as the AWCC and Cf252 is used with passive systems such as the HLNC. Normalization measurements with the UNCL are always done with the third option.

If you select "Use AmLi source for normalization test", you will get a dialog box with the following items:

- AmLi source id
- Normalization constant
- Normalization constant error
- AmLi reference singles rate
- AmLi reference singles date
- Acceptance limit (%)

You enter the id of your AmLi source. The normalization constant and error are initially 1 and 0, respectively. When you make a normalization measurement, the new normalization constant and error are displayed here. You can enter the normalization constant and error from the keyboard here, if necessary for special situations. When you make an initial source measurement with an AmLi source, the singles rate and date are stored as the AmLi reference rate and date and are displayed here. You can enter the reference rate and date from the keyboard, if necessary. The acceptance limit in

percent determines whether the result of a normalization measurement is accepted. If the measurement produces a normalization constant that differs from 1 by more than the acceptance limit, then the constant is saved as the new normalization constant; otherwise, the normalization constant is set to 1 and the error is set to 0.

If you select “Use Cf252 source for normalization test”, you will get a dialog box with the following items:

- Cf252 source id
- Normalization constant
- Normalization constant error
- Cf252 reference doubles rate
- Cf252 reference doubles rate error
- Cf252 reference doubles date
- Precision limit (%)
- Acceptance limit (std dev)
- Acceptance limit (%)

This is similar to the dialog box for AmLi normalization. The Cf252 reference rate error is included here because the counting-statistics error of the doubles rate is not necessarily negligible. Likewise, a precision limit is included. If an initial source or normalization measurement produces a precision for the doubles rate that is greater (i.e., worse) than the precision limit, then the result is not accepted. There are two acceptance limits. If a normalization measurement produces a normalization constant that differs from 1 by more than the acceptance limit in percent and by more than the acceptance limit in standard deviations, then the constant is saved as the new normalization constant; otherwise, the normalization constant is set to 1 and the error is set to 0.

If you are using an add-a-source system, you can use the add-a-source as the normalization source. If you want to do this, check the add-a-source box at the bottom of the window and enter the desired position for the add-a-source during initial-source and normalization measurements.

If you select “Collar normalization test”, you will get a dialog box with the following items:

- AmLi source id
- Neutron yield relative to MRC-95
- Normalization constant
- Normalization constant error
- MRC-95 reference singles rate
- MRC-95 reference singles date
- Acceptance limit (%)

All the AmLi sources and collars have been cross-calibrated and are referenced to the AmLi source MRC-95. You can use any AmLi source for collar verification if you know its yield relative to

MRC-95. Many AmLi relative source yields are listed in Table II of the Los Alamos report “Neutron Collar Calibration and Evaluation for Assay of LWR Fuel Assemblies Containing Burnable Neutron Absorbers”, LA-11965-MS (1990), p. 4. Many reference singles rates and dates for MRC-95 in UNCL detectors are listed in Tables XII-XV of this report [columns “T0 (empty)” and “T0 date”, respectively]. The acceptance limit is the same as described above.

Unattended Measurements Setup

To use this feature, select *Maintain / Unattended Measurements Setup*. This will bring up the “Unattended Measurement Parameters” dialog box which is detector dependent.

INCC can be used in conjunction with Radiation Review to analyze measurements acquired in unattended mode by either Shift Register Collect or Multi-Instrument Collect. In this case, Radiation Review can send a data matching message to INCC requesting the display of the previously imported verification measurement for the detector specified in the message that most closely matches the requested date and time. If the time difference between the requested date and time and the measurement date and time exceeds (plus or minus) the maximum time in seconds specified by a parameter entered from the “Unattended Measurement Parameters” dialog box, then a message will be displayed indicating no match was found for the requested verification measurement date and time.

When importing measurements from Radiation Review you have the option of being presented with an acquire dialog box for checking and possibly changing parameters as each measurement is imported or you can check the “Auto import” box here and have INCC use whatever parameters were previously entered for the item id of the current measurement. If no item id parameters were previously entered then you will be presented with an acquire dialog box regardless of whether or not the “Auto import” box was checked.

QC and Test Parameters

To use this feature, select *Maintain / QC and Test Parameters*. The program performs several quality control tests on the measurement data. One of these is a checksum test that is always applied to multiplicity data to check for internal consistency. There are no test parameters for this test, because exact agreement is required.

When you start a measurement of any type under *Acquire*, you can select whether or not to use the optional quality control tests. If you use the quality control (QC tests), the program will perform the accidentals/singles test and outlier test.

Measurements normally consist of repeat cycles, for example, 10 cycles of 100 seconds each. The accidentals/singles test compares the singles rate with the accidental coincidence rate at the end of

each cycle. If the neutron source rate is constant during the cycle, then, within statistical errors, the accidentals rate should equal the square of the singles rate times the gate length. If the rates do not agree within statistical errors and the quality control tests are turned on, then the cycle is rejected and another is made automatically. The limit of acceptance is set by the parameter "Accidentals/singles test outlier limit (sigma)", which is the limit expressed in standard deviations. The usual limit is 4 standard deviations.

There are two additional limits used by the accidentals/singles test. The first of these is the "Accidentals/singles test rate limit (1/seconds)", which is usually set to 1000 1/second. The accidentals/singles test is not done if the singles rate is below this limit. The reason for this limit is that, at low count rates, room background variations can make the test fail, even though the system is working normally. For the same reason, the test is never done for passive background measurements.

The other additional limit is the "Accidentals/singles test precision limit (%)", which is usually set to 0.1%. If the accidentals and singles rates agree within this limit, the accidentals/singles statistical test is not done and the cycle is accepted. The reason for this limit is that the test can fail for cycles with excellent precision even though the accidentals/singles agreement is satisfactory.

The outlier test compares the results of individual cycles with the average of all the cycles and rejects cycles that fall outside the test limit. Additional cycles are then made automatically, if needed, to replace any rejected cycles. The parameter is "Outlier test limit (sigma)", which is the test limit expressed in standard deviations. The usual limit is 3 standard deviations. For verification measurements, the outlier test is done on the assay mass calculated for each of the cycles. For most other measurements, the outlier test is done on the doubles and triples rates. The outlier test is not done for precision measurements, because the purpose of the precision test is to compare the observed and theoretical standard deviations.

The measurement control chi-squared limit, expressed in percent, determines the upper and lower bounds for the chi-squared test; the limit is the probability that the measured chi-squared value will be between the upper and lower limits in the ideal case where the system is perfectly stable and the theoretical standard deviation is known exactly. The default value for the chi-squared limit is 99%.

To prevent a series of bad measurements from continuing indefinitely, there is a test parameter called "Max # of checksum or accidentals/singles failures", which is normally set to 10. If the number of cycles that fail these tests exceeds the limit, the measurement is stopped and the results are calculated, if possible, from any good cycles in the data set. To effectively disable this test, set this value to a large number, for example 1000.

If two or more passive analysis methods have been selected, then an automatic comparison of the verification results is made. The accepted verification result will be the "normal" analysis method unless it differs from the "backup" method by more than n standard deviations, where n is the "Normal/backup verification test limit (sigma)".

A comparison of the requested and actual high voltage is made after each cycle to insure that the high voltage has not drifted. If the “High voltage test limit (%)” is exceeded, that cycle is marked as having failed the HV test. The default value is 1 percent. To disable the test, set this value to 1000. It may occasionally be of interest to know what the high voltage is for each cycle. This can be done by setting this parameter to zero which will cause the high voltage to be displayed for every cycle.

A checkbox is provided for disabling consistency tests between shift register and multiplicity data if a multiplicity shift register is being used. These tests should only be turned off (box not checked) for very high counting rates where the multiplicity counter will overflow. The singles rate at which overflow will occur is dependent on gate length, and is approximately 1.5 million singles per second for a gate length of 64 microseconds. A smaller gate length will allow counting at higher rates before overflow occurs.

Two radio buttons are provided for choosing how to calculate the doubles rate. If you choose “Measure accidentals count rates” from the shift register then the following equation is used:

$$\text{Doubles rate} = ((\text{Reals} + \text{Accidentals}) - \text{Accidentals}) / \text{count time}$$

If you choose “Calculate the accidentals count rates (T^2G)” then the following equation is used:

$$\text{Doubles rate} = ((\text{Reals} + \text{Accidentals}) - (\text{singles} * \text{singles} * \text{gate length})) / \text{count time}$$

If you choose to calculate the accidentals rates then the error analysis will automatically be set to the sample standard deviation method. The default is to use the measured accidentals rates. When the doubles rate is obtained from the calculated accidentals coincidence rate, the doubles rate for a complete measurement is calculated as the average of the doubles rates for the individual cycles and differs slightly from the doubles rate calculated from the summed raw data; this method was chosen because the calculation assumes that the singles rate is constant during the data collection, and this is more likely to be true for each cycle than for the entire measurement.

Stratum Rejection Limits

To use this feature, select *Maintain / Stratum Rejection Limits*. For each stratum id you can enter a historical bias, historical random uncertainty and historical systematic uncertainty. These values may also be obtained from Stratum Authority disk files by using *File / Get External Data / Stratum Authority File*. For verification measurements the mass acceptance test is as follows:

$$\text{Total uncertainty (delta)} = \text{sqrt}(\text{random}^2 + \text{systematic}^2)$$

Then the acceptance range is:

$$\text{bias} - 3 * \text{delta} \leq ((\text{declared mass} - \text{measured mass}) / \text{declared mass}) \leq \text{bias} + 3 * \text{delta}$$

If the measured mass is outside this acceptance range, then the measurement will be marked as having failed the quality test on all results displays and printouts and the discrepancy/anomaly flag will be set to “Y” and the delta value will be reported as the relative standard deviation in the PSA/Logsheet output file.

Error Calculation Method

To use this feature, select *Maintain / Error Calculation Method*.

There are two choices for calculating the measurement errors that result from counting statistics fluctuations: theoretical standard deviation and sample standard deviation. The theoretical standard deviations are calculated from error models that approximate the true errors; these errors are accurate to within about $\pm 15\%$ and can be calculated from any number of cycles. The sample standard deviations are calculated from the observed scatter of repeated cycles; the accuracy of these errors is determined by the number of cycles. The relative error of the sample standard deviation is $1 / \sqrt{2n}$, where n is the number of cycles.

The default selection is theoretical standard deviations. For highly multiplying items, the theoretical error models underestimate the true errors by 50 to 100%, so sample standard deviations are recommended for this kind of material.

Archive

To use this feature, select *Maintain / Archive*.

The Archive dialog box provides the user with the ability to control the number of days before an automatic file archive or automatic file deletion action is taken in each of three cases:

1. For each measurement, ASCII results files are created in the `\DATA` subdirectory, and then automatically moved to the `\DATA\ARCHIVE` subdirectory after a specified number of days. The default is 90 days.
2. **After the specified number of days, ASCII measurement results files are automatically deleted from both the `\DATA` subdirectory and the `\DATA\ARCHIVE` subdirectory.** The default is 1000 days.
3. **After the specified number of days, measurement results are automatically deleted from the INCC database..** The default is 10000 days, effectively disabling this option.

To effectively disable some or all of these features, simply set the number of days to a very large number. However, automatic archive and deletion prevent the \DATA directory and the database from becoming very large and thus degrading performance.

Warning: INCC and all other applications will be unable to execute if the database becomes so large that it uses all the available hard disk space.

Detector Add/Delete

To use this feature, select *Maintain / Detector Add/Delete*. A default detector id of XXXX/XXX/YY is provided with INCC when it is installed. The first four characters are the detector type, for example AWCC, the middle three characters identify the detector, and the last two characters are the configuration id.

To add a new detector, select “Add detector” from the dialog box, and then a dialog box will be displayed for you to type in the new detector (maximum of 11 characters in the form XXXX/XXX/YY) which will be placed in the detector id list. There is a maximum of 40 detectors. The detector type will automatically be converted to all uppercase letters.

To delete a detector, select “Delete detector” from the dialog box, and then a dialog box will be displayed for you to select the detector to be deleted from a drop down list.

Facility Add/Delete

To use this feature, select *Maintain / Facility Add/Delete*. A default facility of XXXX is provided with INCC when it is installed.

To add a new facility, select “Add facility” from the dialog box, and then a dialog box will be displayed for you to type in the new facility (maximum of 5 characters) and facility description (maximum of 20 characters) which will be placed in the facility list. There is a maximum of 40 facilities. The facility will automatically be converted to all uppercase letters.

To delete a facility, select “Delete facility” from the dialog box, and then a dialog box will be displayed for you to select the facility to be deleted from a drop down list.

MBA Add/Delete

To use this feature, select *Maintain / MBA Add/Delete*. A default Material Balance Area (MBA) of XXXX is provided with INCC when it is installed.

To add a new MBA, select “Add material balance area” from the dialog box, and then a dialog box will be displayed for you to type in the new MBA (maximum of 4 characters) and MBA description (maximum of 20 characters) which will be placed in the MBA list. There is a maximum of 40 material balance areas. The MBA will automatically be converted to all uppercase letters.

To delete an MBA, select “Delete material balance area” from the dialog box, and then a dialog box will be displayed for you to select the MBA to be deleted from a drop down list.

Stratum Id Add/Delete

To use this feature, select *Maintain / Stratum Id Add/Delete*.

To add a new stratum id, select “Add stratum id” from the dialog box, and then a dialog box will be displayed for you to type in the new stratum id (maximum of five characters) and description (maximum of 20 characters) which will be placed in the stratum id list. There is a maximum of 50 stratum ids. The stratum id will automatically be converted to all uppercase letters.

To delete a stratum id, select “Delete stratum id” from the dialog box, and then a dialog box will be displayed for you to select the stratum id to be deleted from a drop down list.

Material Type Add/Delete

To use this feature, select *Maintain / Material Type Add/Delete*. A default material type of Pu is provided with INCC when it is installed.

To add a new material type, select “Add material type” from the dialog box, and then a dialog box will be displayed for you to type in the new material type (maximum of five characters) which will be placed in the material type list. There is a maximum of 40 material types.

To delete an material type, select “Delete material type” from the dialog box, and then a dialog box will be displayed for you to select the material type to be deleted from a drop down list.

Poison Rod Type Add/Delete

To use this feature, select *Maintain / Poison Rod Type Add/Delete*. A default poison rod type of G for gadolinium is provided with INCC when it is installed.

To add a new poison type, select “Add poison rod type” from the dialog box, and then a dialog box will be displayed for you to type in the new poison rod type (maximum of one character) and its

poison absorption factor (default is .647) which will be placed in the poison rod type list. There is a maximum of 10 poison types.

To delete a poison rod type, select “Delete poison rod type” from the dialog box, and then a dialog box will be displayed for you to select the poison rod type to be deleted from a drop down list.

Glovebox Add/Edit/Delete

To use this feature, select *Maintain / Glovebox Add/Edit/Delete*.

This feature is used only for holdup measurements performed using the *Acquire / Holdup* option. It allows glovebox measurement geometries to be defined, edited, or removed from the database. The existing glovebox configurations can also be printed from here. In order to perform a measurement with *Acquire / Holdup*, it is necessary to have at least one glovebox defined. Four pieces of information are required to define a glovebox: (1) a glovebox identification number, (2) the number of rows (i.e. the number of vertical measurement positions), (3) the number of columns (i.e. the number of horizontal measurement positions), and (4) the distance between the detector and the glovebox. Item 4 is only for information purposes and is not required. The maximum number of rows allowed is 2 (minimum is 1), and the maximum number of columns allowed is 6 (minimum is 1).

To add a new glovebox, select “Add glovebox” from the dialog box, and then a dialog box will be displayed for you to type in the new glovebox id (maximum of 20 characters) and its dimensions (1 or 2 rows and 1 to 6 columns) which will be placed in the glovebox id list. There is a maximum of 60 glovebox ids.

To delete a glovebox, select “Delete glovebox” from the dialog box, and then a dialog box will be displayed for you to select the glovebox id to be deleted from a drop down list.

To change the dimensions of an existing glovebox, select “Edit an existing glovebox...” from the dialog box.

To display and optionally print all the defined gloveboxes and their configuration, select “Display glovebox configuration...” from the dialog box.

Add-a-source Setup

To use this feature, select *Maintain / Add-a-source Setup*. *Add-a-source Setup* is only used for systems with either a manual or automated add-a-source. It provides the method for setting up the manual add-a-source placement or setting up a CompuMotor 4000, CompuMotor 3000, JCC21 series PLC, WM3100 series or Canberra counter PLC to be used to move the ²⁵²Cf source into

position for verification measurements. First select which type of hardware is to be used to control movement of the ^{252}Cf source by clicking on the appropriate radio button. Then select the “OK” button.

If CompuMotor 4000 or CompuMotor 3000 is selected, the CompuMotor setup screen will be displayed. You must select COM1 or COM2. The distance to the over travel switches, the CompuMotor steps per inch, the bit mask settings, the axis number and the bit state when the CompuMotor is in an over travel switch depend upon how the CompuMotor was installed, and should only have to be set once. The number of and distances to measurement positions depend upon the physical configuration of the detector and the type of material being measured. Select the CompuMotor serial port that matches the hardware setup.

If JCC21 Series PLC, WM3100 series PLC or Canberra counter PLC is selected, the PLC setup screen will be displayed. You must select COM1 or COM2. The number of and distance to measurement positions depend upon the physical configuration of the detector and the type of material being measured. The WM3100 series PLC will automatically control opening and closing the door and turning the drum rotator on and off.

If manual is selected, the Manual Add-a-source Setup screen will be displayed. Enter the number of ^{252}Cf source positions to be measured. The first measurement will be without the ^{252}Cf source, and the remaining measurements will be with the ^{252}Cf source. A message will be displayed when the ^{252}Cf source should be moved to a new position.

Delete Measurements

To use this feature, select *Maintain / Delete Measurements*. This feature allows the user to delete measurements from the database that are no longer needed. A chronological list of all measurements is displayed, one per line. Click on the line for each measurement to be deleted, and it will be highlighted in blue. When you have selected all the measurements you want to delete, select the “OK” button.

Acquire Submenu

In maintenance mode *Acquire* contains all measurement data acquisition methods. In Inspection mode only background, normalization, verification and holdup are available.

The data acquisition methods are rates only, background, initial source, normalization, precision, verification, calibration and holdup. Each of these data acquisition methods has at least one setup dialog box that you must fill in to acquire data. The following data entry elements are common to all data acquisition methods:

Comment

Count time

Option to acquire using number of cycles or measurement precision

Number of cycles

Precision, minimum and maximum number of cycles for measurement precision acquisition

Data source

QC tests

Print results

Display results options

Ending comment option

Comments are optional.

A measurement consists of the number of good cycles requested, for example, 10 cycles of 100 seconds each or the number of cycles needed to achieve the requested precision.

The data source can be shift register, database, disk file or manual entry. For background, normalization and verification measurements only, the data source can be 'review disk file', indicating that the data came from either the Shift Register Review or Radiation Review program:

"Shift register" is the normal data acquisition mode from shift register electronics.

"Database" refers to the database of previously acquired measurement data.

"Disk file" refers to specially formatted disk files that allow arbitrary measurement data sets to be analyzed.

"Manual entry" allows the user to type in a count time, measurement date and up to 200 sets of totals (singles), reals plus accidentals and accidentals.

"Review disk file" refers to measurement data files that have been exported from the Shift Register Review or Radiation Review program in NCC format.

If you select "Database" as the data source, you will get a list of previous measurements of the same method. When you select one of the previous measurements, the raw measurement data for that measurement are read from the database and are processed as though they came from the shift register. All of the parameters that are used to process the data are the current parameters in the database. This allows you, for example, to reanalyze old measurement data with different background, deadtime, calibration coefficients, etc. Measurements can only be reanalyzed one at a time.

Disk files are primarily intended for software diagnostics, but can also be used to import measurement data that were acquired without the use of this program. You can find the required format for these disk files in “Test data file format”. If you select "Disk file" as the data source, you will be asked to enter or select the filename for the file that contains your data. Each measurement must be in a separate file.

Manual entry is primarily intended for software diagnostics, but can also be used to import measurement data that were acquired without the use of this program.

You can acquire data with or without the quality control tests on. You should have the quality control tests on unless there is a special need to turn them off. The quality control tests that you can turn off are the accidentals/singles test and the outlier test. These are explained in “Test parameters”. If the box labeled "QC tests" is checked, the quality control tests are turned on.

If the box labeled "Print results" is checked, the results will be printed at the end of each measurement. While a results text window is displayed, you can print it by clicking in the upper left corner of the window and then selecting “Print” from the drop down menu. If you do not print the results at the end of each measurement, you can print them later by selecting *Report*.

Check the ending comment box if you want to be able to add a description of the measurement when it has completed.

You can select the detail to display and print by checking boxes for the desired options *under Setup / Facility/Inspection*.

When the doubles rate is obtained from the calculated accidentals coincidence rate, the doubles rate for a complete measurement is calculated as the average of the doubles rates for the individual cycles and differs slightly from the doubles rate calculated from the summed raw data; this method was chosen because the calculation assumes that the singles rate is constant during the data collection, and this is more likely to be true for each cycle than for the entire measurement.

Rates Only Acquire

To use this feature, select *Acquire / Rates only*. A "Rates only" measurement is a general purpose measurement used simply to get singles, doubles, triples and scaler count rates. You can enter an item id to identify the measurement. The program does nothing with the results except save them in the database. This measurement method corrects the raw data for deadtime and normalization, and subtracts background. These measurements can later be reanalyzed as verification measurements by selecting “Database” as the data source after selecting *Acquire / Verification*.

Background Acquire

To use this feature, select *Acquire / Background*. You can make two kinds of background measurements: passive and active. The passive background is room background only. The active background is room background plus the background from the AmLi interrogating sources in active systems. When you make a passive background measurement, the background singles and error, doubles and error, triples and error, and scaler rates are saved and are subtracted from the measured rates of future measurements. When you make an active background measurement, only the singles and error and scaler rates are saved and subtracted from the singles and scaler rates of future active measurements. Every time you make a background measurement, the previous background rates are replaced with the new background rates. You can also change the background rates manually by selecting *Maintain / Background Setup*. A background measurement will replace any rates entered manually. Background measurements are corrected for deadtime.

Initial Source Acquire

To use this feature, select *Acquire / Initial Source*. Except for UNCL detectors, you use the initial source measurement to obtain the reference count rate and date for normalization measurements. If you use an AmLi source, then the singles rate is the reference rate. If you use a Cf252 source, then the doubles rate is the reference rate and the precision of the doubles rate must be better than the precision limit specified in *Maintain / Normalization Setup* for the result to be accepted. After the successful completion of the initial source measurement, the reference rate and date are saved in the database; you can view these values under *Maintain / Normalization Setup*. For Cf252 sources, the standard deviation of the doubles rate is also saved, because this error might not be negligible.

Normalization Acquire

You use the normalization measurement to determine whether the detector efficiency has changed since the initial source measurement. The type of source (AmLi or Cf252) and the source id are specified under *Maintain / Normalization Setup*. If Cf252 is the source type, then the precision of the measured doubles rate must be better than the precision limit set in *Maintain / Normalization Setup* for the result to be accepted. For Cf252 sources the normalization constant is the expected doubles rate divided by the measured doubles rate; for AmLi sources the normalization constant is the square of the ratio of the expected singles rate to the measured singles rate. For AmLi sources, if the normalization constant thus calculated differs from 1 by less than the acceptance limit specified in *Maintain / Normalization Setup*, then it is set to 1 and its error is set to 0. For Cf252 sources, if the normalization constant thus calculated differs from 1 by less than either of the acceptance limits specified in *Maintain / Normalization Setup*, then it is set to 1 and its error is set to 0.

Precision Acquire

There are two kinds of measurement control, normalization and precision. To use this feature, select *Acquire / Precision*. You can use the precision test to verify that the scatter in the doubles rate in a series of cycles is the result of counting statistics only rather than counting statistics plus detector instability or electronic instability. The precision test compares the observed scatter to the theoretical scatter (the sample standard deviation to the theoretical standard deviation) using a chi-square test. The chi-square test value is the square of the ratio of sample to theoretical standard deviations. If the test ratio falls outside these limits, you will get a "Fail" message. Because there is a 1% chance of failing the test with a properly operating system, you should repeat the test if you get a failure. If you get consistent failures, the system needs repair.

Note, however, that the theoretical standard deviation is calculated from an approximate error model. You can force the precision test to fail by using a large number of cycles such that the error of the sample standard deviation is smaller than the error in the statistical error model. A reasonable range for the number of cycles is 15 to 30.

Verification Acquire

To use this feature, select *Acquire / Verification*. You can use the verification measurement to get the assay mass and error for an item using one or more analysis methods. Enter the id of your item and select the material type most appropriate for the item. The analysis methods for the material type selected must have already been set up by selecting *Maintain / Calibration / Analysis Methods*.

Select the "Isotopics" button to enter the isotopic composition of your item. The dialog box is the same as that obtained by selecting *Setup / Isotopics*, so you can enter the isotopic composition either here or there. Composite isotopics may also be entered by selecting the "Composite isotopics" button. The dialog box is the same as that obtained by selecting *Setup / Composite Isotopics*, so you can enter the composite isotopic composition either here or there.

There is an entry labeled "Declared total Pu or ^{235}U mass (g)". If you enter a declared mass for the verification item, the program will compare the assay mass with the declared mass in the results. If you set the declared mass to zero, then the comparison of assay and declared masses is not done.

You will get as many results sets as you have selected analysis methods. For passive verification measurements there is an automatic comparison of different analysis methods when two or more have been selected. The accepted verification result will be the "normal" method unless the result from the "backup" method differs by more than n standard deviations from the normal method, where n is a test parameter that can be set by selecting *Maintain / QC and Test Parameters*. If the two methods differ by more than the test limit then the backup result is accepted. The accepted result will be highlighted.

If the Curium Ratio analysis method is selected, a second dialog box will appear after the ‘Verification Measurement’ dialog box. This is the Curium Ratio dialog box. The following facility supplied parameters should be entered into their respective cells:

Monthly batch identification	<i>Monthly batch id</i>
Input batch identification	<i>Input batch id</i>
Value of the declared total uranium mass in grams (if provided)	<i>Declared U (g)</i>
Value of the declared ²³⁵ U mass in grams (if provided)	<i>Declared U235 (g)</i>
Curium-to-plutonium mass ratio	<i>Cm (g) / Pu (g) ratio</i>
Curium-to-plutonium mass ratio error	<i>Cm/Pu ratio error</i>
Curium-to-plutonium mass ratio analysis date	<i>Cm/Pu ratio date</i>
Curium-to-uranium mass ratio	<i>Cm (g) / U (g) ratio</i>
Curium-to- uranium mass ratio error	<i>Cm/U ratio error</i>
Curium-to- uranium mass ratio analysis date	<i>Cm/U ratio date</i>

If the plutonium isotopics are known, an effective half-life for the Pu can be entered (*Pu effective half-life (yr)*). The default value is the half-life of ²⁴⁰Pu. The effective half-life can be calculated using the following equation:

$$t^{1/2} = 87.7 * f_{238} + 24100 * f_{239} + 6564 * f_{240} + 14.4 * f_{241} + 376000 * f_{242}$$

where:

- $t^{1/2}$ is the effective half-life of the sample in years
- f_{238} is the isotopic fraction of ²³⁸Pu
- f_{239} is the isotopic fraction of ²³⁹Pu
- f_{240} is the isotopic fraction of ²⁴⁰Pu
- f_{241} is the isotopic fraction of ²⁴¹Pu
- f_{242} is the isotopic fraction of ²⁴²Pu

Note: The date format is determined by the computer settings which may be accessed through the control panel by clicking on the “Regional settings” icon.

Calibration Measurements Acquire

To use this feature, select *Acquire / Calibration Measurements*. You can use calibration measurements to collect data to obtain calibration curves for verification measurements. The calibration option is useful for passive verification using the calibration curve, known alpha, and add-a-source methods, and for active verification using the calibration curve technique. The calibration option is not useful for the other verification methods such as holdup, collar and multiplicity, because the calibration procedures for them are not as simple and must be done outside this program.

For passive verifications the calibration curve relates doubles rate to effective ^{240}Pu mass. For active verifications the calibration curve relates doubles rate to ^{235}U mass. The result of a calibration measurement is the doubles rate and the effective ^{240}Pu or the ^{235}U mass. After several calibration measurements are done for a particular material type, the calibration results can be used to generate a calibration curve using the Deming least squares program.

The doubles rate for the known alpha method is the doubles rate corrected for neutron multiplication. The program will calculate the doubles rate corrected for multiplication from the measured singles and doubles rates and from the alpha weight and rho-zero values entered by selecting *Maintain / Calibration / Known Alpha*. You should be certain, therefore, that the alpha weight and rho-zero values for your material type are entered in the calibration parameters before you make calibration measurements for the known alpha analysis method. If you forget to do this, all is not lost. You can enter the values later and then acquire calibration data using "Database" as the data source. This way you can reanalyze your calibration measurement data with the correct alpha weight and rho-zero values.

Holdup Acquire

To use this feature, select *Acquire / Holdup*. You can use the holdup acquire measurement option to determine the assay mass and error for a glovebox that is composed of i rows and j columns for a total of $i * j$ measurement positions. The count data are collected for each measurement position, and then averaged together to obtain a single measurement value. This single value is then used to calculate the mass of the holdup material from the calibration data. Only two analysis methods are valid for the holdup acquire feature: passive calibration curve and known alpha.

At the holdup dialog screen, enter the glovebox id, item id (which maybe the same as the glovebox id), and material type. Select any other acquire options as desired from the dialog screen. Enter the count time in seconds and the number of cycles that will be used for each glovebox measurement position.

Select the "Isotopics" button to enter the isotopic composition of your item. The dialog box is the same as that obtained by selecting *Setup / Isotopics*, so you can enter the isotopic composition either here or there. Composite isotopics may also be entered by selecting the "Composite isotopics" button. The dialog box is the same as that obtained by selecting *Setup / Composite isotopics*, so you can enter the composite isotopic composition either here or there.

There is an entry labeled "Declared total Pu or ^{235}U mass (g)". If you enter a declared mass for the verification item, the program will compare the assay mass with the declared mass in the results. If you set the declared mass to zero, then the comparison of assay and declared masses is not done.

After pressing “OK” from the holdup dialog screen, a second screen appears showing the measurement positions for the glovebox selected. Click on the corresponding position to be measured, and then click “Measure selected glovebox position” to start the measurement. Each measurement cycle is displayed on the screen with the corresponding statistical error for the doubles rate. The position measurement can be stopped prematurely by clicking on “Quit measurement with results” to save the data acquired or by clicking on “abort measurement” if the data are to be discarded. Once the measurement finishes, the “Select next holdup measurement position” screen reappears. The position just measured turns a different color and displays the doubles count rate and its statistical error. Another position can now be measured or remeasured by clicking on the appropriate location.

Once all the positions have been measured, click on “Quit measurement with results” from the “Select next holdup measurement position” screen. This ends the measurement for the glovebox and saves the data. The results of the measurement are displayed on the screen.

Reanalyze Submenu

Provides the ability to analyze any previous verification or holdup measurement in the database, and only change one or a few selected parameters.

Verification Reanalysis

There are two ways to reanalyze previously acquired verification measurements.

One is by selecting *Acquire / Verification*, and then selecting “Database” as the data source. If you do this, only the raw data from the original measurement will be used, and all the parameters currently in effect, for example calibration, background, detector, etc., will be used to analyze the data and calculate a mass.

The other way is to use this feature by selecting *Reanalyze / Verification*. Using this technique, you can analyze a previous measurement, and only change one or a few selected parameters. The parameters you can change are shown in the “Verification Measurement Reanalysis” dialog box, and are material type (which would also affect the calibration), item id, stratum id, declared mass, normalization constant and error, inventory change code. I/O code, comment, ending comment, isotopics and background. You can also choose whether to use the original calibration or the current calibration for the selected material type and analysis methods. You also have the option of creating a new measurement and saving the original, or overwriting the original measurement.

Holdup Reanalysis

There are two ways to reanalyze previously acquired holdup measurements.

One is by selecting *Acquire / Holdup*, and then selecting “Database” as the data source. If you do this, only the raw data from the original measurement will be used, and all the parameters currently in effect, for example calibration, background, detector, etc., will be used to analyze the data and calculate a mass.

The other way is to use this feature by selecting *Reanalyze / Holdup*. Using this technique, you can analyze a previous measurement, and only change one or a few selected parameters. The parameters you can change are shown in the “Holdup Measurement Reanalysis” dialog box, and are material type (which would also affect the calibration), item id, stratum id, declared mass, normalization constant and error, comment, ending comment, isotopics and background. You can also choose whether to use the original calibration or the current calibration for the selected material type and analysis methods. You also have the option of creating a new measurement and saving the original, or overwriting the original measurement.

Report Submenu

Report contains all options for review and reporting of previously acquired measurement data, an option to write a summary of verification or holdup measurements in spreadsheet format, and an option to plot measurement data with their calibration curve.

In Inspection mode you can only review background, initial source, normalization, verification and holdup measurements.

All Measurements Report

To use this feature, select *Report / All Measurements*. This feature allows you to review any measurement of any type. It functions the same way as the other report options except that you get a list of all the measurements.

Rates Only Report

To use this feature, select *Report / Rates Only*. This feature allows you to review the raw data and results from previous *Rates Only* data acquisitions. You will get a dialog box to select the desired report options, a print option and the type of report desired.

The types of reports are “Display results in text” and “Plot singles, doubles and triples”.

If you select “Plot singles, doubles and triples”, all other options will be grayed out. When you select the “OK” button, the next screen will be a list, in inverse chronological order, of all rates only results. Click on all the results you want to report. The selected lines will be highlighted in blue. Then select the “OK” button. A graphical plot of the singles, doubles and triples will be displayed for each results set selected. The display contains options for printing the graph, zooming both the x and y axes, and manual scaling. The graphed results will remain in display windows until you manually close each one.

If you select “Display results in text”, you can check the "Print" box to have the report data printed exactly as displayed. You can also select which results are to be displayed by checking the appropriate boxes. The next screen will be a list, in inverse chronological order, of all rates only results. Click on all the results that you want to report. The selected lines will be highlighted in blue. Then select the "OK" button. All of the selected results will be displayed in cascaded windows and also printed, if the "Print" box was checked. The displayed results will remain in display windows until you manually close each one. The results displayed are the same as those displayed at the end of a rates only data acquisition.

Background Report

To use this feature, select *Report / Background*. This feature allows you to review the raw data and results from previous *Background* data acquisitions. You will get a dialog box to select the desired reports options, a print option and the type of report desired.

The types of reports are “Display results in text” and “Plot singles, doubles and triples”.

If you select “Plot singles, doubles and triples”, all other options will be grayed out. When you select the “OK” button, the next screen will be a list, in inverse chronological order, of all background results. Click on all the results you want to report. The selected lines will be highlighted in blue. Then select the “OK” button. A graphical plot of the singles, doubles and triples will be displayed for each results set selected. The display contains options for printing the graph, zooming both the x and y axes, and manual scaling. The graphed results will remain in display windows until you manually close each one.

If you select “Display results in text”, you can check the "Print" box to have the report data printed exactly as displayed. You can also select which results are to be displayed by checking the appropriate boxes. The next screen will be a list, in inverse chronological order, of all background results. Click on all the results that you want to report. The selected lines will be highlighted in blue. Then select the "OK" button. All of the selected results will be displayed in cascaded windows and also printed, if the "Print" box was checked. The displayed results will remain in

display windows until you manually close each one. The results displayed are the same as those displayed at the end of a background data acquisition.

Initial Source Report

To use this feature, select *Report / Initial Source*. This feature allows you to review the raw data and results from previous *Initial Source* data acquisitions. You will get a dialog box to select the desired report options, a print option and the type of report desired.

The types of reports are “Display results in text” and “Plot singles, doubles and triples”.

If you select “Plot singles, doubles and triples”, all other options will be grayed out. When you select the “OK” button, the next screen will be a list, in inverse chronological order, of all initial source results. Click on all the results you want to report. The selected lines will be highlighted in blue. Then select the “OK” button. A graphical plot of the singles, doubles and triples will be displayed for each results set selected. The display contains options for printing the graph, zooming both the x and y axes, and manual scaling. The graphed results will remain in display windows until you manually close each one.

If you select “Display results in text”, you can check the "Print" box to have the report data printed exactly as displayed. You can also select which results are to be displayed by checking the appropriate boxes. The next screen will be a list, in inverse chronological order, of all normalization results. Click on all the results that you want to report. The selected lines will be highlighted in blue. Then select the "OK" button. All of the selected results will be displayed in cascaded windows and also printed, if the "Print" box was checked. The displayed results will remain in display windows until you manually close each one. The results displayed are the same as those displayed at the end of an initial source data acquisition.

Normalization Report

To use this feature, select *Report / Normalization*. This feature allows you to review the raw data and results from previous *Normalization* data acquisitions. You will get a dialog box to select the desired report options, a print option and the type of report desired.

The types of reports are “Display results in text” and “Plot singles, doubles and triples”.

If you select “Plot singles, doubles and triples”, all other options will be grayed out. When you select the “OK” button, the next screen will be a list, in inverse chronological order, of all normalization results. Click on all the results you want to report. The selected lines will be highlighted in blue. Then select the “OK” button. A graphical plot of the singles, doubles and triples

will be displayed for each results set selected. The display contains options for printing the graph, zooming both the x and y axes, and manual scaling. The graphed results will remain in display windows until you manually close each one.

If you select “Display results in text”, you can check the "Print" box to have the report data printed exactly as displayed. You can also select which results are to be displayed by checking the appropriate boxes. The next screen will be a list, in inverse chronological order, of all normalization results. Click on all the results that you want to report. The selected lines will be highlighted in blue. Then select the "OK" button. All of the selected results will be displayed in cascaded windows and also printed, if the "Print" box was checked. The displayed results will remain in display windows until you manually close each one. The results displayed are the same as those displayed at the end of a normalization data acquisition.

Precision Report

To use this feature, select *Report / Precision*. This feature allows you to review the raw data and results from previous *Precision* data acquisitions. You will get a dialog box to select the desired report options, a print option and the type of report desired.

The types of reports are “Display results in text” and “Plot singles, doubles and triples”.

If you select “Plot singles, doubles and triples”, all other options will be grayed out. When you select the “OK” button, the next screen will be a list, in inverse chronological order, of all precision results. Click on all the results you want to report. The selected lines will be highlighted in blue. Then select the “OK” button. A graphical plot of the singles, doubles and triples will be displayed for each results set selected. The display contains options for printing the graph, zooming both the x and y axes, and manual scaling. The graphed results will remain in display windows until you manually close each one.

If you select “Display results in text”, you can check the "Print" box to have the report data printed exactly as displayed. You can also select which results are to be displayed by checking the appropriate boxes. The next screen will be a list, in inverse chronological order, of all precision results. Click on all the results that you want to report. The selected lines will be highlighted in blue. Then select the "OK" button. All of the selected results will be displayed in cascaded windows and also printed, if the "Print" box was checked. The displayed results will remain in display windows until you manually close each one. The results displayed are the same as those displayed at the end of a precision data acquisition.

Verification Report

To use this feature, select *Report / Verification*. This feature allows you to review the raw data and results from previous *Verification* data acquisitions. You will get a dialog box to select the desired report options, a print option and the type of report desired. You must also select the desired inspection number or select "All" if you want to be able to report any verification measurement.

The types of reports are “Display results in text” and “Plot singles, doubles and triples”.

If you select “Plot singles, doubles and triples”, all other options will be grayed out. When you select the “OK” button, the next screen will be a list, in inverse chronological order, of all verification results. Click on all the results you want to report. The selected lines will be highlighted in blue. Then select the “OK” button. A graphical plot of the singles, doubles and triples will be displayed for each results set selected. The display contains options for printing the graph, zooming both the x and y axes, and manual scaling. The graphed results will remain in display windows until you manually close each one.

If you select “Display results in text”, you can check the "Print" box to have the report data printed exactly as displayed. You can also select which results are to be displayed by checking the appropriate boxes. The next screen will be a list, in inverse chronological order, of all verification results. Click on all the results that you want to report. The selected lines will be highlighted in blue. Then select the "OK" button. All of the selected results will be displayed in cascaded windows and also printed, if the "Print" box was checked. The displayed results will remain in display windows until you manually close each one. The results displayed are the same as those displayed at the end of a verification data acquisition.

Calibration Report

To use this feature, select *Report / Calibration*. This feature allows you to review the raw data and results from previous *Calibration* data acquisitions. You will get a dialog box to select the desired report options, a print option and the type of report desired.

The types of reports are “Display results in text” and “Plot singles, doubles and triples”.

If you select “Plot singles, doubles and triples”, all other options will be grayed out. When you select the “OK” button, the next screen will be a list, in inverse chronological order, of all calibration results. Click on all the results you want to report. The selected lines will be highlighted in blue. Then select the “OK” button. A graphical plot of the singles, doubles and triples will be displayed for each results set selected. The display contains options for printing the graph, zooming both the x and y axes, and manual scaling. The graphed results will remain in display windows until you manually close each one.

If you select “Display results in text”, you can check the "Print" box to have the report data printed exactly as displayed. You can also select which results are to be displayed by checking the

appropriate boxes. The next screen will be a list, in inverse chronological order, of all calibration results. Click on all the results that you want to report. The selected lines will be highlighted in blue. Then select the "OK" button. All of the selected results will be displayed in cascaded windows and also printed, if the "Print" box was checked. The displayed results will remain in display windows until you manually close each one. The results displayed are the same as those displayed at the end of a calibration data acquisition.

Holdup Report

To use this feature, select *Report / Holdup*. This feature allows you to review the raw data and results from previous *Holdup* data acquisitions. A dialog box appears so you can select the results to display and the print option. You must select the desired inspection number or select "All" if you want to be able to select any holdup measurement for a report. Next, the "Measurement selection" screen shows the available holdup measurement files available. More than one file can be selected for displaying and printing at one time. The list of available files can also be printed from the "Measurement selection" screen.

Verification Summary

To use this feature, select *Report / Verification Summary*. This feature allows the user to create a disk file in comma separated variable (CSV) spreadsheet format for a selected set of verification measurement values and a selected analysis method. Check the boxes for the measurement values you want to include, and type in the full disk drive, path and file name where you want the data to be written. You may also check the print box if you want a hard copy of what is written to the disk file. You must also select the desired inspection number or select "All" if you want to be able to include any verification measurement in the summary. Select the starting and ending date and time for the measurements you want to be able to include in the summary. The initial default starting date is 97/01/01 and the initial default ending date and time is the current date and time so that if you make no changes you will automatically get all verification measurements. You can use the radio buttons to choose between getting the current ending date time or the last entered ending date and time the next time you use the verification summary feature. The starting date and time will always be the last one entered.

When you select the "OK" button, you will be presented with a list of all verification measurements for the selected analysis method, in inverse chronological order. Click on all the verification measurements you want to have included in the CSV spreadsheet format disk file. They will be highlighted in blue. Then select the "OK" button to write the file. The contents of the file will also be displayed on the screen. The first line contains all the column headers. Following the column header line is one line of values for each verification measurement selected.

Holdup Summary

To use this feature, select *Report / Holdup Summary*. This feature allows the user to create a disk file in comma separated variable (CSV) spreadsheet format for a selected set of holdup measurement values. Check the boxes for the measurement values you want to include, and type in the full disk drive, path and file name where you want the data to be written. You may also check the print box if you want a hard copy of what is written to the disk file. You must also select the desired inspection number or select "All" if you want to be able to include any holdup measurement in the summary.. Select the starting and ending date and time for the measurements you want to be able to include in the summary. The initial default starting date is 97/01/01 and the initial default ending date and time is the current date and time so that if you make no changes you will automatically get all holdup measurements. You can use the radio buttons to choose between getting the current ending date time or the last entered ending date and time the next time you use the holdup summary feature. The starting date and time will always be the last one entered.

When you select the "OK" button, you will be presented with a list of holdup measurements in inverse chronological order. Click on all the holdup measurements you want to have included in the CSV spreadsheet format disk file. They will be highlighted in blue. Then select the "OK" button to write the file. The contents of the file will also be displayed on the screen. The first line contains all the column headers. Following the column header line is a single line of the values for each holdup measurement selected.

Plot Calibration and Verification Results

To use this feature, select *Report / Plot Calibration and Verification Results*. For a selected material type and analysis method, a list of verification measurements with a declared mass is presented for user selection. The selected verification measurements will be plotted in yellow as individual data points. The calibration curve will be plotted in cyan, and the individual data points used to create the calibration curve will also be plotted in cyan if they are available (the calibration curve was created using Deming called from INCC). The plotted data may also be printed by clicking on the "Print plot of calibration and verification results" check box.

When you select the "OK" button you will be presented with a list of all verification measurements for the selected material type and analysis method, in inverse chronological order. Click on all the verification measurements you want to have included in the plot. They will be highlighted in blue. Then select the "OK" button to plot the data.

Tools Submenu

Tools Contains an option providing the user with the ability to have Radiation Review display the peak corresponding to the most recently displayed INCC verification measurement.

Select Another Review Tool

1. When *Tools / Select Another Review Tool* is clicked, a dialog box containing a button for each installed review tool is displayed unless there are no other review tools installed, in which case an error message is displayed.
2. The user clicks on the button for the desired review tool.
3. A data matching message is sent to the selected review tool containing the date, time and detector id corresponding to the start of the last verification or normalization measurement displayed.
Steps 2 and 3 may be repeated for additional review tools.

Window Submenu

Window contains options for arranging measurement data windows.

Arrange Icons

To use this windows arrangement feature, select *Window / Arrange Icons*. If measurement data display forms have been minimized, selecting *Arrange Icons* will arrange them in rows.

Cascade

To use this windows arrangement feature, select *Window / Cascade*. Selecting *Cascade* will cause the most recent measurement results data display form to be fully in view, and all other forms to be arranged descending one on top of the other, with only the left edge and title exposed. Clicking on a partially hidden form will bring it to the front. INCC will automatically delete the oldest measurement results display if there are more than 20 that have not been manually deleted.

Tile

To use this windows arrangement feature, select *Window / Tile*. Selecting *Tile* will cause all the measurement data display forms to be in view as much as possible. This feature is useful when you want to compare two or more measurement results.

Help Submenu

Help contains two options, *Topics* which has most of the information contained in this manual, and *About INCC* which contains copyright information, the date and version number of INCC being used and authorship credits.

Topics

To use this feature, select *Help / Topics*. This feature has most of the information contained in this manual. It is structured in the standard windows help format, including a table of contents, topic search and hypertext links.

About INCC

To use this feature, select *Help / About INCC*. When *About INCC* is selected, a screen will appear showing copyright information and the current INCC version number and release date. Selecting the “Credits” button will display a dialog box listing the authors of this software.

Files

Input files

Stratum Authority File Format

All **values within a record** must be separated by commas and there must not be any carriage return and line feed (CRLF). If a text string contains a space, tab or comma , it must be enclosed in double quotes. All fields must always be present. Each **record** must be terminated by a carriage return and line feed (CRLF), but no comma.

The default file name is NCCstrat.dat

Stratum Authority files are entirely in text (ASCII).

Record format:

Facility code	4 characters
Stratum id	5 characters
Stratum description	20 characters
Historical bias	floating point number
Historical random uncertainty	floating point number
Historical systematic uncertainty	floating point number

Item Relevant Data File Format

All **values within a record** must be separated by commas and there must not be any carriage return and line feed (CRLF). If a text string contains a space, tab or comma, it must be enclosed in double quotes. All fields must always be present. Each **record** must be terminated by a carriage return and line feed (CRLF), but no comma.

The default file name is NCC_Item.dat

Item Relevant Data files are entirely in text (ASCII).

Record format:

Facility code	4 characters
MBA code	4 characters
Item id	12 characters
Stratum id	5 characters
Inventory change code	2 characters
I/O code	1 character
Material type	5 characters
Isotopics source code	2 characters
possible values: OD, IA, IM, OA, OC, OE, OS, CO	
Item type	1 character
blank	normal item
P	component item
C	composite item
L	LWR fuel assembly
Isotopics id	12 characters
Declared fuel rod length (cm)	floating point
Declared fuel rod length error	floating point
Declared total Pu (g)	floating point
Declared total Pu error	floating point
Declared depleted U (g)	floating point
Declared depleted U error	floating point
Declared natural U (g)	floating point
Declared natural U error	floating point
Declared enriched U (g)	floating point
Declared enriched U error	floating point
Declared total U235 (g)	floating point
Declared total U235 error	floating point
Declared total U238 (g)	floating point
Declared total U238 error	floating point
Pu 238 %	floating point

Pu 239 %	floating point
Pu 240 %	floating point
Pu 241 %	floating point
Pu 242 %	floating point
Pu isotopics measurement date	YYYYMMDD
Am 241 %	floating point
Am isotopics measurement date	YYYYMMDD
Pu 238 error	floating point
Pu 239 error	floating point
Pu 240 error	floating point
Pu 241 error	floating point
Pu 242 error	floating point
Am 241 error	floating point
Isotopics type	1 character
P = permanent, don't ever delete from database (not currently used)	
Declared total rods	integer
Declared total poison rods	integer
Declared poison %	floating point
Declared poison % error	floating point
Declared rod type	1 character

Isotopics Data File Format

All **values within a record** must be separated by commas and there must not be any carriage return and line feed (CRLF). If a text string contains a space, tab or comma, it must be enclosed in double quotes. All fields must always be present. Each **record** must be terminated by a carriage return and line feed (CRLF), but no comma. There can be up to 1000 sets of isotopics in the INCC database.

Isotopics data files are entirely in text (ASCII).

Record format:

Isotopics id, Isotopics source code, ²³⁸Pu, ²³⁹Pu, ²⁴⁰Pu, ²⁴¹Pu, ²⁴²Pu, Pu date, ²⁴¹Am, Am date, ²³⁸Pu error, ²³⁹Pu error, ²⁴⁰Pu error, ²⁴¹Pu error, ²⁴²Pu error, ²⁴¹Am error

Only the first 12 characters of the isotopics id will be used. If the isotopics id contains a space or other white space character, it must be enclosed in double quotes.

The possible two character isotopics source codes are: OD, IA, IM, OA, OC, OE, OS, CO.

All isotopic values are in weight % Pu.

All error values are in weight % Pu.

The date format is: YYYYMMDD

Composite Isotopics Data File Format

All **values within a record** must be separated by commas and there must not be any carriage return and line feed (CRLF). If a text string contains a space, tab or comma, it must be enclosed in double quotes. All fields must always be present. Each **record** must be terminated by a carriage return and line feed (CRLF), but no comma.

Composite isotopics data files are entirely in text (ASCII).

First record format

Isotopics id, Isotopics source code, Pu mass, ²³⁸Pu, ²³⁹Pu, ²⁴⁰Pu, ²⁴¹Pu, ²⁴²Pu, Pu date, ²⁴¹Am, Am date, ²³⁸Pu error, ²³⁹Pu error, ²⁴⁰Pu error, ²⁴¹Pu error, ²⁴²Pu error, ²⁴¹Am error

Format of all records except the first:

Pu mass, ²³⁸Pu, ²³⁹Pu, ²⁴⁰Pu, ²⁴¹Pu, ²⁴²Pu, Pu date, ²⁴¹Am, Am date, ²³⁸Pu error, ²³⁹Pu error, ²⁴⁰Pu error, ²⁴¹Pu error, ²⁴²Pu error, ²⁴¹Am error

Only the first 12 characters of the isotopics id will be used. If the isotopics id contains a space or other white space character, it must be enclosed in double quotes.

The possible two character isotopics source codes are: OD, IA, IM, OA, OC, OE, OS, CO.

Mass is in grams Pu. Composite isotopics are weighted by mass.

All isotopic values are in weight % Pu.

All error values are in weight % Pu.

The date format is: YYYYMMDD

Repeat the mass, isotopic values and error values for each set of isotopics up to a maximum of six.

Test Data File Format

Test data files are entirely in text (ASCII), and all values must be separated by white space:

Number of cycles (n)
Count time per cycle in seconds

Repeat the following lines for each of n cycles:

Singles 1st Scaler 2nd Scaler Reals + Accidentals Accidentals
Number of multiplicity values (m)
1st multiplicity reals + accidentals 1st multiplicity accidentals
2nd multiplicity reals + accidentals 2nd multiplicity accidentals
.
.
.
mth multiplicity reals + accidentals mth multiplicity accidentals

If add-a-source data, append the following for each add-a-source position:

Number of cycles for add-a-source position i (n)
Count time for add-a-source position i

Repeat the following lines for each of n add-a-source position i cycles:

Singles 1st scaler 2nd scaler Reals + Accidentals Accidentals
Number of multiplicity values (m)
1st multiplicity reals + accidentals 1st multiplicity accidentals
2nd multiplicity reals + accidentals 2nd multiplicity accidentals
.
.
.
mth multiplicity reals + accidentals mth multiplicity accidentals

Holdup Test Data File Format

Holdup test data files are entirely in text (ASCII), and all values must be separated by white space. The number of rows must be 1 or 2, and the number of columns must be between 1 and 6, inclusive:

Number of glovebox rows (i)
Number of glovebox columns (j)

Repeat the following lines for each glovebox row and column (i,j):

Number of cycles (n)
Count time per cycle in seconds

Repeat the following lines for each of n cycles:

Singles Reals + Accidentals Accidentals

Radiation Review Measurement Data File Format

Radiation Review Measurement Data File format (binary), file extension is always .NCC:

Header

“IREV” 4 characters specifying the file type
1 character B = background, N = normalization, V = verification
11 character detector id (XXXX/YYYY/ZZ)

where:

XXXX = detector type, e.g. PCAS

YYY = detector identifier, e.g. 004

ZZ = configuration id, usually 01

12 character item id (filled with trailing blanks if less than 12 characters)

yy.mm.dd, 8 characters, date of first cycle

hh:mm:ss, 8 characters, time of first cycle

unsigned short, number of cycles

Repeated for each cycle in the measurement

yy.mm.dd, 8 characters, date of cycle i

hh:mm:ss, 8 characters, time of cycle i

unsigned short, count time in seconds for cycle i

double, totals for cycle i

double, R+A for cycle i

double, accidentals for cycle i

double, scaler 1 for cycle i

double, scaler 2 for cycle i

unsigned short, number of multiplicity values for cycle i (n = 0 to 128)

n unsigned longs, non-zero R+A multiplicity distributions for cycle i

n unsigned longs, non-zero accidentals multiplicity distributions for cycle i

Note: All cycles in a verification or normalization measurement must have the same count time. Background measurements may have cycles with different count times because all the cycles will be summed into one cycle.

Output files

File Naming Conventions

The text (ASCII) data file naming convention for measurement results is based on the date and time of day of the measurement as follows:

YMDHMMSS
Y = last digit of the year
M = month (0-9, A-C)
D = day (0-9, A-V)
H = hour (A-X)
MM = minutes (00-59)
SS = seconds (00-59)

Rates only files have a suffix of .RTS

Background files have a suffix of .BKG

Initial source files have a suffix of .INS

Normalization files have a suffix of .NOR

Precision files have a suffix of .PRE

Verification files have a suffix of .VER

Calibration files have a suffix of .CAL

Holdup files have a suffix of .HUP

PSA Operator-Inspector Measurement Database and Logsheet File Format

All values will be separated by commas. If a text string contains a space or other white space character, it will be enclosed in double quotes. All fields will always be present. NULL strings (“”) or zeros will be used when a field is not applicable.. All floating point values will have six digits to the right of the decimal point.

The default file name is NCC_PSA.dat

Facility code	4 characters
MBA code	4 characters
Stratum id	5 characters
Item id	12 characters
Material type	5 characters
Inspection year	YYYY
Inspection number	3 characters
Measurement date	YYYYMMDD
Measurement time	HHMMSS
Detector type	4 characters
Detector id	8 characters
Configuration id	2 characters
Electronics id	8 characters
Measurement number	integer
Inventory change code	2 characters
I/O code	1 character
Operator's declarations:	
Isotopics id	12 characters
Pu total (g)	floating point
U total (g)	floating point
U235 total (g)	floating point
U235 %	floating point
Pu 238 %	floating point
Pu 239 %	floating point
Pu 240 %	floating point
Pu 241 %	floating point
Pu 242 %	floating point
Pu isotopics measurement date	YYYYMMDD
Am 241 %	floating point
Am isotopics measurement date	YYYYMMDD
Inspector's measurements:	
Isotopics id	12 characters
Isotopics source code	2 characters

Pu total, uncorrected (g)		floating point
Pu total, known alpha (g)		floating point
Pu total, multiplicity (g)		floating point
Pu total, known M (g)		floating point
Pu total, add-a-source (g)		floating point
Pu total, primary analysis method (g)		floating point
Primary analysis method		1 character
U	uncorrected	
C	known alpha (multiplication corrected)	
K	known M	
M	multiplicity	
A	add-a-source	
R	curium ratio	
T	truncated multiplicity	
NULL	none	
U total (g)		floating point
U235 total (g)		floating point
U235 %		floating point
Pu 238 %		floating point
Pu 239 %		floating point
Pu 240 %		floating point
Pu 241 %		floating point
Pu 242 %		floating point
Pu isotopics measurement date		YYYYMMDD
Am 241 %		floating point
Am isotopics measurement date		YYYYMMDD
Relative standard deviation		floating point
(total uncertainty for the stratum)		
Discrepancy/anomaly (Y/N)		1 character
(Y = primary analysis method failed stratum RSD uncertainty test)		
(N = primary analysis method passed stratum RSD uncertainty test)		

Performance Monitoring File Format

All values will be separated by commas. If a text string contains a space or other white space character, it will be enclosed in double quotes. All fields will always be present. NULL strings (“”) or zeros will be used when a field is not applicable. All floating point values will have six digits to the right of the decimal point.

This file contains only initial source and normalization measurements.

The default file name is NCC_perf.dat

Facility code	4 characters
MBA code	4 characters
Inspection year	YYYY
Inspection number	3 characters
Measurement date	YYYYMMDD
Measurement time	HHMMSS
Measurement type	1 character
(S = initial source, N = normalization)	
Detector type	4 characters
Detector id	8 characters
Configuration id	2 characters
Electronics id	8 characters
Normalization source id	12 characters
Measurement, total good count time	integer
Singles sum	integer
R + A sum	integer
Reals sum	integer
Normalization constant	floating point
Ratio expected/measured singles or doubles rate	floating point
Ratio expected/measured singles or doubles rate error	floating point
Normalization test pass (Y/N)	1 character

Appendix

Data Processing

Data processing - raw data

The raw data depend on the type of shift register electronics used. All shift register electronics provide the counting time, the total counts, the real-plus-accidental (R+A) coincidence counts, and the accidental (A) coincidence counts. In addition, multiplicity electronics provide two multiplicity distributions, the (R+A) distribution and the (A) distribution. Some electronics also collect data from one or two auxiliary scalers. A measurement can consist of one or more cycles, each of which produces a raw data set. All raw data from all cycles are saved in the results file for the measurement.

Data processing - checksum test

The checksum test is a quality control test used with multiplicity electronics. The sum of the counts in the accidental multiplicity distribution must equal the total neutron count. Also, the first moment of the (R+A) multiplicity distribution must equal the (R+A) coincidence counts and the first moment of the (A) distribution must equal the (A) coincidence counts. If any of these conditions is not met and the checksum test is enabled, a checksum error is generated and the measurement data from the cycle are not further processed. The multiplicity electronics can measure multiplicities from 0 to 255, but only multiplicities from 0 to 127 are used by the software; this is because the deadtime correction procedure hasn't been developed for larger multiplicities. If the measured distribution produces multiplicities larger than 127 and the checksum test is enabled, a checksum error will occur. If the test fails, another cycle is made to replace the failed cycle. However, if n consecutive cycles (default: 10) fail, the measurement is aborted. Failure of the checksum test indicates a hardware problem unless the largest multiplicity is greater than 127. If the checksum test is enabled, it is performed even if the quality control (QC) tests are turned off.

Data processing - accidentals/singles test

The measured totals rate (or singles rate) is the totals count divided by the measurement time. The accidental coincidence rate is the accidental coincidence counts divided by the measurement time. If the neutron count rate is constant (within statistical errors) during a measurement, then the accidental coincidence rate should equal the gate length times the square of the singles rate (within statistical errors) [1]. The empirical standard deviation of the ratio of the accidental coincidence rate to the gate length times the square of the singles rate is approximately the reciprocal square root of the accidental coincidence counts. If this ratio is more than n standard deviations (default: 4) from unity, an accidentals/singles test error is generated and the measurement data from the cycle are not further processed. The accidentals/singles test is not done for background measurements and is not done when the total count rate is below some minimum value (default: 1000 counts/s). Also, the test always passes if the accidental coincidence rate and the gate length times the square of the singles rate are the same within n % (default: 0.1 %). No deadtime corrections are done for the accidentals/singles test. The test is done whenever the quality control (QC) tests are selected at the beginning of the measurement.

Data processing - outlier test

At the end of each cycle during a measurement, the outlier test compares the doubles and triples rates for each cycle in a measurement with the average doubles and triples rates for the measurement, respectively. If one or more values is at least n standard deviations (default: 3) from the average, the largest deviate is rejected as an outlier. The test is then continued until no outliers are found or until there are only two cycles left; the test is not made when there are just one or two cycles initially. If an outlier is found, an additional cycle is made automatically to replace the rejected cycle. An exception to this procedure occurs when more than n (default is 100) cycles are requested at the beginning of the measurement. In this case all the requested cycles are collected first and the outlier test is done in one pass: all cycles with a doubles or triples rate greater than n standard deviations (default: 3) from the respective average are rejected and no replacement measurements are made. The outlier test is not applied to precision measurements. The test is done whenever the quality control (QC) tests are selected at the beginning of the measurement.

Data processing - deadtime corrected count rates and errors

The singles rate and the doubles rate are corrected for deadtime using the deadtime correction equations of Ref. 2, and the deadtime corrected triples rate is calculated using the equations of Ref. 3. The standard deviations of the count rates are determined in one of two ways as selected under *Maintain / Error Calculation Method*: theoretical standard deviations (default selection) and sample standard deviations. If theoretical standard deviations are selected, the errors for the singles and doubles rates are calculated from the equations in section 2.5 of Ref. 3 and the error for the triples

rate is calculated from the equations in section 3 of Ref. 3. If sample standard deviations are selected, then the count rate errors are calculated as the sample standard deviations of the rates from the individual cycles in a measurement. If there is only one cycle, the sample standard deviations are set to zero. All measurements are corrected for deadtime except precision measurements.

Data processing - average rates

After all cycles for a measurement are finished and any outliers are rejected, the summed raw data for the individual cycles are used to calculate the final rates. The final standard deviations for the rates depend on the calculation method selected. If the errors are calculated from theory, then they are calculated from the summed raw data. If they are calculated from the sample standard deviations, then the relative error of the average rate is the sample standard deviation divided by the average rate of the individual cycles and then divided by the square root of the number of cycles.

Data processing - background subtraction

The singles, doubles, and triples rates for passive and active background measurements can either be measured or entered from the keyboard under *Maintain / Background*. The present background rates are subtracted from the deadtime corrected rates obtained in calibration, verification, holdup, initial source, normalization, and rates only measurements.

Measurements

Rates Only

Rates only measurements produce singles, doubles, and triples rates and errors as the only result. The rates are corrected for deadtime, passive background, and normalization.

Background

Passive background measurements automatically replace previous passive singles, doubles, and triples background rates with the new measured rates. In passive background measurements, a warning message is generated if the doubles rate or the triples rate exceeds n counts/s (default: 1 count/second). An active background measurement automatically replaces the previous active background singles rate. The passive doubles and triples background rates are used for the active doubles and triples background rates.

Initial Source

For AmLi initial source measurements, excluding the UNCL, the singles rate and measurement date are stored in the database as the reference values for normalization measurements. For Cf252 initial source measurements the doubles rate and error and the measurement date are stored in the database as the reference values for normalization measurements. These rates are corrected for deadtime and background.

Normalization

The normalization measurement determines a normalization constant to correct for a change in the detector efficiency since the initial source measurement. For Cf252 normalization measurements the normalization constant is the ratio of the expected doubles rate to the measured doubles rate; the expected rate is calculated from the initial source data and the 2.645-year Cf252 half-life. If the normalization constant is less than n standard deviations (default: 3) from unity or is less than m percent (default: 4) from unity, then the normalization constant is set to 1 and the error is set to 0. For AmLi normalization measurements the normalization constant is the square of the ratio of the expected singles rate to the measured singles rate; the expected rate is calculated from the initial source data and the 433.6-year Am241 half-life. If the normalization constant is less than m percent (default: 4) from unity, then the normalization constant is set to 1 and the error is set to 0.

Precision

Precision measurements test the short term system stability by determining whether the observed scatter in a series of doubles measurements is statistically consistent with the expected scatter. The tested value is chi-square. The upper and lower acceptance limits are determined by the number of cycles and the confidence level (default: 99%). No corrections are done to the doubles rates for this test, but the checksum test and the accidentals/singles test are applied. The result is the measured chi-square value, the upper and lower limits, and a pass/fail message.

Verification measurements - general

There are five types of passive verifications and four types of active verifications. The passive verifications determine Pu mass [1] and the active verifications (except for active multiplicity) determine ^{235}U mass. All verifications start with the measurement of count rates as described above, followed by one or more verification calculations. Each verification type has its own analysis method; the rates from an item can be analyzed with several analysis methods as selected by the user. The Pu isotopic composition is used by all of the passive methods to convert the effective ^{240}Pu mass to Pu mass [1]; it is also used with the ^{241}Am content in the known alpha method to

calculate the alpha value [1] and in the known multiplication method to calculate the effective ^{239}Pu mass [4]. The Pu and Am content is decay corrected from the analysis date or dates to the verification date using the half lives from Ref. 5; the decay of ^{241}Pu to ^{237}U with 0.002% probability is ignored. In approximation, the percent errors of the Pu isotopes after decay are set equal to the percent errors before decay and the error of the ^{241}Am mass after decay is obtained by combining the contributions from the ^{241}Am before decay and the ^{241}Pu that decays to ^{241}Am . Each of the verification methods is covered in a separate section below.

Verification measurements - passive calibration curve

The verification is based on a calibration curve of doubles rate (after all corrections) vs. effective ^{240}Pu mass. Four curve types are provided with the general form $D = D(m, a, b, \dots)$, where D is the doubles rate, m is the effective ^{240}Pu mass, and a, b , etc. are calibration constants. The effective ^{240}Pu mass is calculated from D, a, b , etc. and the standard deviation of m is calculated using standard error propagation techniques [6]. In addition, an extra error term labeled “Sigma x (%)” is included to account for sources of error that are not included in the errors of D, a, b , etc. The quantity “Sigma x (%)”, converted to mass, is combined in quadrature with the standard deviation of m to produce the final standard deviation of m . The Pu mass is then calculated from m and the isotopic composition; the error of the Pu mass is calculated with standard error propagation techniques using the errors of m and the Pu isotopes.

The polynomial curve type can have more than one solution for a specified doubles rate. In this case the software selects the smallest mass that is within the upper and lower mass limits. If there is no solution within the mass limits, then the software selects the smallest positive mass. If there is no positive mass, then the least negative mass is selected.

Verification measurements - known alpha

The verification is based on a calibration curve of multiplication corrected doubles rate vs. effective ^{240}Pu mass [1]. The multiplication corrected doubles rate D_c is calculated from the singles and doubles rates, the alpha value, rho-zero, and a constant k . The alpha value is calculated [1] from the Pu isotopic composition and the alpha weight. The alpha weight is a factor used to weight the alpha value calculated for pure oxide; e.g., for pure oxide the alpha weight is 1 and for pure metal the alpha weight is 0. Rho-zero is the ratio of the doubles to singles rates times $(1 + \quad)$ for a nonmultiplying item of ^{240}Pu . The constant k is 2.062 in Ref. 1; a value of 2.166 (default) makes k consistent with the multiplicity analysis parameters below. The effect of switching between 2.062 and 2.166 is small for most items. The calibration curve has the form $D_c = a + bm$, where a and b are calibration constants. Otherwise, the analysis procedure is the same as for the passive calibration curve procedure.

Verification measurements - known M

The verification is based on a calibration curve of multiplication vs. effective ^{239}Pu [4]. The equations relating the singles and doubles rates to the effective ^{240}Pu mass, multiplication (M), and alpha are the same as for the known alpha technique. Alpha and the effective ^{240}Pu mass are the unknowns; M is determined from the calibration curve. The only function for the calibration curve presently in the software is $M = 1 + am + bm^2$, where m is the effective ^{239}Pu mass, and a and b are calibration constants. There is presently no error calculation for the effective ^{240}Pu mass; the only error assigned to the effective ^{240}Pu mass is that from the extra error component “Sigma x (%)”.

Verification measurements - passive multiplicity

The verification is based on the equations in Ref. 7 that relate the singles, doubles, and triples rates to the effective ^{240}Pu mass, multiplication and alpha. If theoretical standard deviations are selected, the errors of the effective ^{240}Pu mass, multiplication and alpha are calculated using the error analysis method of Ref. 3. There is an empirical correction factor that is applied to the effective ^{240}Pu verification mass to account for a normalization required for items with high neutron multiplication. The correction factor has the form $k = a + b(M-1) + c(M-1)^2$, where M is the neutron multiplication and a , b and c are calibration constants. The correction factor is usually set to 1. The verification depends on the first, second, and third factorial moments of the neutron multiplicity distribution for ^{240}Pu spontaneous fission (default values: 2.154, 3.789, and 5.211, respectively [8]) and for the 2-MeV induced fission of ^{239}Pu (default values: 3.163, 8.240, and 17.321, respectively [9]); it also depends on the spontaneous fission rate of ^{240}Pu (default: 473.5 fissions/g s [8, 10]).

Verification measurements - add-a-source

The add-a-source verification technique is described in Ref. 11. The add-a-source correction factor f has the form $f = 1 + a + b + c^2 + d^3$, where a , b , c , and d are calibration constants and $k = D_{ref} / (D_{meas} - 1)$, where D_{ref} is the reference doubles rate decayed to the measurement date and D_{meas} is the doubles rate from the verification item with the Cf add-a-source less the doubles rate from the verification item alone. These doubles rates involving the add-a-source are averages over up to five positions of the source. The measured doubles rate from the item is multiplied by f and the Pu verification mass is then determined as described above under “Verification measurement - passive calibration curve”.

Verification measurements - curium ratio

Curium ratio analysis is an indirect method of determining the mass of plutonium and uranium from an observed curium neutron measurement. The curium ratio method was developed for the analysis

of waste streams in spent fuel reprocessing facilities. In these waste streams, ^{244}Cm is the dominant neutron producing species.

This method requires a chemical analysis of the waste stream, after extraction of the plutonium and uranium has been completed, to determine the concentrations of ^{244}Cm , plutonium, and uranium. Ratios of grams curium per gram plutonium and grams curium per gram uranium can then be formed. These ratios are used as input parameters for the curium ratio analysis. It has been shown that these ratios remain constant throughout the waste treatment process (concentration, vitrification) [14,15,16].

The actual neutron measurement is an observation of ^{244}Cm spontaneous fission neutrons. Using a typical passive calibration curve analysis, the mass of curium can be determined. The values of the Cm/Pu and Cm/U ratios are then applied to determine the mass of Pu and U from the observed Cm mass. The ratios are decay corrected from the chemical analysis date to the measurement date within the INCC program. Errors in these ratios are propagated and included in the error ascribed to the determined masses. The ^{235}U mass is also calculated by INCC, but this mass obtained from the ratio of the operator declared masses for ^{235}U and U.

In the case of analysis of vitrified wastes, coincidence measurements (doubles) are required to determine the curium mass because the vitrification process results in a significant (alpha,n) neutron production rate which is treated as an unknown. In the case of leached hulls measurements, there is no significant (alpha,n) production and one can obtain the mass of Pu and U from singles measurements.

Verification measurements - truncated multiplicity

The truncated multiplicity method is used for the measurement of very small Pu items when the cosmic ray background interferes with the measurement. Truncated multiplicity analysis uses only the first three multiplicity values (the zeros, ones, and twos) in the multiplicity distributions and thus ignores the higher multiplicities that are produced primarily by cosmic rays; this improves the precision of the assay mass. Truncated multiplicity analysis is an example of gate multiplicity analysis and is described in Ref. 17.

Verification measurements - active calibration curve

This is the same as verification by passive calibration curve, except that the calibration mass is ^{235}U rather than ^{240}Pu and the doubles rate is corrected for the decay of the AmLi sources.

Verification measurements - collar

The verification is based on the algorithms in Ref. 12 for thermal-mode and fast-mode active measurements of LWR fuel. The error analysis is essentially that described in Ref. 13.

Verification measurements - active multiplicity

In its present state of development, the active multiplicity technique does not verify the ^{235}U mass of an item; it is only able to determine the neutron multiplication of the item. The multiplication is determined from the triples and doubles rates using the active multiplicity equations; the doubles and triples rates in the active multiplicity equations are the same as those in the passive multiplicity equations [7] except that the spontaneous fission moments are replaced by the thermal neutron induced fission moments of ^{235}U , the induced fission moments are replaced by the 2-MeV induced fission moments of ^{235}U , and the spontaneous fission rate is replaced by the rate of ^{235}U fissions induced by AmLi neutrons. The calculation requires the first, second, and third factorial moments of the thermal neutron induced fission of ^{235}U (default values: 2.414, 4.638, and 6.818, respectively [9]) and of the 2-MeV induced fission of ^{235}U (default values: 2.637, 5.623, and 9.476, respectively [9]).

Verification measurements - active/passive

Active/passive verification is used for active verification (except UNCL verification) when the item has a significant passive neutron yield. The item is measured with and without the americium-lithium (AmLi) interrogation sources. The net doubles rate is used for the verification exactly as for verification by active calibration curve.

Holdup measurements

The holdup measurement option performs multiple measurements of a glovebox at different positions, and then averages the count rate data from each position into a single value for use in calculating the ^{240}Pu effective mass in a glovebox. The multiple measurements are obtained from scanning the glovebox with neutron slab detectors. The INCC software controls the data collection so that all the measurements for a single glovebox are stored in one data file.

Calibration

Calibration measurements are the same as verification measurements, except that the verification masses are not calculated.

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Database Recovery Procedure

Database corrupted

The database may only be reinitialized by reinstalling INCC. This is a way of recovering from a corrupted database, but will result in the loss of all measurement data, calibration parameters and setup parameters. If possible, first use *File / Save As/Export / Transfer* to preserve any measurement data you do not want to lose. Use *File / Save As/Export / Initial Data* to preserve any measurement (detector) parameters and calibration parameters you do not want to lose. You must be in maintenance mode to access the *Initial Data option*. After the database has been reinitialized, you can use *Get External Data / Transfer* to try to recover the saved measurement data, and *Get External Data / Initial Data* to try to recover the saved measurement (detector) parameters and calibration parameters.

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